

1997

**Standard Specifications
For
Public Works Construction**



**Department of Public Works
Engineering Division**

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PART I**GENERAL PROVISIONS**

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SECTION 1**ABBREVIATIONS AND DEFINITIONS**

When the following abbreviations and terms are used in the specifications or on the plans, they are to be construed the same as the respective expressions represented:

1-1 ABBREVIATIONS

<u>Abbreviations</u>	<u>Word or Words</u>
AAN	American Association of Nurserymen
AASHTO ..	American Association of State Highway and Transportation Officials
AC	Asphalt Concrete
ACI	American Concrete Institute
AGC	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
APWA.....	American Public Works Association
AREA.....	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
Asph.....	Asphalt
ASTM	American Society for Testing and Materials
AWG.....	American Wire Gage
AWPA.....	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BBL.....	Barrel

BC	Back of Curb
B/L or BL	Base Line
BM	Bench Mark
CB	Catch Basin
C.C. or C/C	Center to Center
CI	Cast Iron or Curb Inlet
CIP	Cast-Iron Pipe
C/L or CL..	Center Line
CMP	Corrugated Metal Pipe
Col	Column
Conc	Concrete
CWT	Hundredweight (100 US pounds)
CY or Cu. Yd	Cubic Yard
DI	Ductile Iron
DOTD	Louisiana Department Transportation and Development
DPW	City-Parish Department of Public Works
Elev	Elevation
FAA	Federal Aviation Administration, Department of Transportation
FH	Fire Hydrant
FHWA.....	Federal Highway Administration, Department of Transportation
FL	Flow Line
FT	Foot or Feet
Galv.....	Galvanized
Gal	US Gallon
Gr	Grade or Gram
H	Height, High or Horizontal
Hor	Inside Diameter
IMSA	International Municipal Signal Association
Inv	Invert
IPCEA	Insulated Power Cable Engineers Association
IP	Iron Pipe
ITE	Institute of Traffic Engineers
LB	US Pound
LF or Lin. Ft.....	Linear Foot or Linear Foot
Lin	Linear
LL	Liquid Limit
Long.....	Longitudinal
Max	Maximum
Mh	Manhole
M	Thousand
m	Meter
MFBM	Thousand Feet, Board Measure
MGAL.....	Thousand Gallons
Min	Minutes or Minimum
Mon	Monument
MUTCD ...	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA.....	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

NOAA.....	National Oceanic and Atmospheric Administration
OC	On Center
OD	Outside Diameter
OSHA.....	Occupational Safety and Health Administration
Oz.	Ounce
PC.	Portland Cement or Point of Curvature
PE.	Polyethylene
PI..	Plasticity Index or Point of Intersection
PL.	Plastic Limit
ppm	Parts Per Million
psf	Pounds Per Square Foot
psi	Pounds Per Square Inch
PT.	Point of Tangency
PVC	Polyvinyl chloride or Point of Vertical Curvature
PVI	Point of Vertical Intersection
PVT	Point of Vertical Tangency
Pvmt	Pavement
QPL	Qualified Products List, Louisiana Department of Transportation and Development
R ..	Radius
RC	Reinforced Concrete
RCCP	Reinforced Concrete Culvert Pipe
RCP	Reinforced Concrete Pipe
RCPA.....	Reinforced Concrete Pipe Arch
Rdwy.....	Roadway
Ret. Wall ...	Retaining Wall
RMA	Rubber Manufacturers Association
R/W or R.O.W.	Right-of-Way
s ...	Slope
SAE	Society of Automotive Engineers
San	Sanitary
San. S. or SS	Sanitary Sewer
Sec	Section or Seconds
SF or Sq. Ft.	Square Foot
Spec.....	Specifications
SSPC	Steel Structures Painting Council
St ..	Street
Sta	Station
Std	Standard
Subs.....	Subsection
SY or Sq. Yd.	Square Yard
T ..	Tangent
UL	Underwriter's Laboratories, Inc.
U.S.C. & G.S.	United States Coast and Geodetic Survey
U.S.G.S. ...	United States Geological Survey
VC	Vitrified Clay or Vertical Curve
Vert	Vertical
W.I	Wrought Iron

Abbreviations and symbols used on plans for steel construction conform to those given in the AISC Steel Construction Manual.

1-2 DEFINITIONS

1-2.1 ADDENDUM - A written or graphic instrument issued before opening bids which clarifies, corrects or changes the bidding or bid documents.

1-2.2 AGREEMENT - A document signed by both parties to the contract for performance of the work, and incorporating all terms and conditions of the contract.

1-2.3 BIDDER - An individual, firm, partnership, corporation or joint venture submitting a proposal on the work contemplated, acting directly or through an authorized representative.

1-2.4 CHANGE ORDER - A written instruction to the contractor, signed by the engineer and the contractor, prescribing a change in the work.

1-2.5 CITY-PARISH - City of Baton Rouge and Parish of East Baton Rouge.

1-2.6 CONTRACT OR CONTRACT DOCUMENTS - The documents covering performance of the work including the formal agreement, advertisement for bids, instructions and notice to bidders, addenda, affidavit, proposal, specifications, bonds and plans.

1-2.7 CONTRACTING AGENCY - The City-Parish or the East Baton Rouge Sewerage Commission, whichever agency is named in the contract.

1-2.8 CONTRACTOR - The individual, firm, partnership, corporation or joint venture entering into a contract with the contracting agency to perform the contemplated work.

1-2.9 COUNCIL - The Metropolitan Council, which is the governing body of the City-Parish.

1-2.10 DAY - A calendar day of 24 hours.

1-2.11 DEPARTMENT OR DEPARTMENT OF PUBLIC WORKS - City-Parish Department of Public Works.

1-2.12 DIRECTOR OF FINANCE - Authorized head of City-Parish Department of Finance charged with receiving, expending and accounting of public money.

1-2.13 DIRECTOR - Authorized head of City-Parish Department of Public Works.

1-2.14 EAST BATON ROUGE SEWERAGE COMMISSION - The contracting agency for certain wastewater and sewerage projects in East Baton Rouge Parish.

1-2.15 ENGINEER - Chief Engineer of City-Parish Department of Public Works or authorized representative.

1-2.16 EXTRA WORK - Work not included in the contract as awarded but deemed essential by the City-Parish to satisfactory completion of the contract within its intended scope.

1-2.17 EXTRA WORK ORDER - A change order concerning the performance of work or the furnishing of materials involving extra work.

1-2.18 HOLIDAY OR LEGAL HOLIDAY - A calendar day observed or authorized by the City-Parish as a non-working day.

1-2.19 INSPECTOR - An authorized representative of the engineer.

1-2.20 LABORATORY - A testing laboratory approved by the engineer.

1-2.21 NOTICE TO PROCEED - Written notice to the contractor to proceed with the contract work, including the date of beginning of contract time.

1-2.22 OWNER - The public body with whom the contractor has entered into a contract and for whom the work is to be done.

1-2.23 PLANS - The plans, profiles, cross sections and drawings approved by the engineer, which show the design and details of the work to be done.

1-2.24 PROFILE GRADE - Trace of a vertical plane intercepting the top surface of the proposed surface grade usually along centerline of roadbed, pipeline or channel.

1-2.25 PROJECT - All works for construction, reconstruction or relocation of a road, sewer, storm drain, water main, pumping station or other structure proposed or under contract within a limited area.

1-2.26 PROJECT ENGINEER - An authorized representative of the engineer who is in charge of the project.

1-2.27 PROJECT SPECIFICATIONS - All Standard Specifications, Special Provisions and other provisions applicable to the project.

1-2.28 PROPOSAL - Written offer of the bidder to perform the contemplated work and furnish the necessary materials submitted on the prescribed form, signed and guaranteed.

1-2.29 PROPOSAL GUARANTY - Certified check, cashier's check or surety bond accompanying the proposal as a guaranty that the bidder, if awarded the contract, will enter into a contract with the City-Parish for performance of the work.

1-2.30 PURCHASING DIRECTOR - Authorized head of City-Parish Division of Purchasing charged with purchase of contractible services and through whom proposals are received from bidders.

1.2.31 QUALIFIED PRODUCTS LIST - The list of approved construction products maintained by the Louisiana Department of Transportation and Development.

1.2.32 REFERENCE SPECIFICATIONS - Bulletins, standards, rules, methods of analysis or test, codes and specifications of other agencies, engineering societies, or industrial associations referred to in the specifications. All such references shall mean the latest edition thereof, unless otherwise specified, including any amendments thereto which are in effect at the time of advertising for bids.

1.2.33 ROADBED - Graded portion of a street or highway within top and side slopes, prepared as a foundation for pavement structure and shoulders.

1.2.34 ROADSIDE - Area adjoining outer edge of roadbed within the right-of-way. Areas between roadways of a divided street or highway may also be considered roadside.

1.2.35 ROADWAY - Portion of right-of-way between outside lines of slopes, gutters or side ditches, including appurtenant structures, and all slopes, ditches, channels, waterways, etc., necessary to proper drainage and protection.

1.2.36 SEWER - A conduit for carrying of domestic sewage or industrial waste.

1.2.37 SPECIAL PROVISIONS - Clauses setting forth conditions or requirements peculiar to the work, and that modify or supplement the Standard Specifications.

1.2.38 STANDARD PLANS - Drawings of structures or devices referred to in the plans or specifications by title or index number.

1.2.39 STANDARD SPECIFICATIONS - A book of specifications for general application and repetitive use.

1.2.40 STATE - The State of Louisiana.

1.2.41 STORM DRAIN - Conduit for carrying storm water and surface water, street wash and other wash waters or drainage, but excludes sewage and industrial wastes; also called "storm sewer". May include open channel type of storm drain.

1.2.42 STORM SEWER - See Storm Drain.

1.2.43 STREET - A road, highway, parkway, freeway, alley, walk, or way, including all area within the right-of-way.

1.2.44 SUBCONTRACTOR - An individual, partnership, corporation or other entity entering into a contract with a contractor to perform part of the work.

1-2.45 SUPERINTENDENT - A representative of the contractor authorized to receive and execute instructions from the engineer, and who shall supervise and direct the construction.

1-2.46 SURETY - The bondsman, party or parties who guarantee fulfillment of the contract by bond.

1-2.47 UNDERSTOOD EXPRESSIONS - To avoid cumbersome repetition of expressions in the contract, it is provided that whenever anything is, or is to be done, if, as, or, when or where "required, determined, directed, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected or condemned," it shall be understood as if the expression were followed by the words "by the engineer" or "to the engineer".

1-2.48 UTILITY - Tracks, overhead or underground wires, pipe lines, conduits, ducts or structures, owned, operated or maintained in or across a public right-of-way or private easement. The word "utility" shall mean either the owner of the utility or the utility itself, whichever is applicable.

1-2.49 WORK - That which is proposed to be constructed or done under the contract.

SECTION 2

BIDDING REQUIREMENTS

2-1 CONTENTS OF PROPOSAL FORM: The engineer will furnish the prospective bidder with a proposal form. This form will state the location and description of the contemplated construction and will show the estimate of the various quantities and kinds of work to be performed or materials to be furnished, and will have a schedule of items for which lump sum or unit bid prices are invited. The proposal form will state the amount of the proposal guaranty, and the date, time and place of the opening of proposals.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder may be required to pay the City-Parish for each set of plans the sum stated in the notice inviting bids, in accordance with State law.

2-2 PREPARATION OF PROPOSAL FORM: Each bidder must submit his proposal on the form furnished by the engineer. Altered or substitute forms will not be accepted. The term "altered" shall mean any change in an item, quantity, price or amount set forth in the schedule of items, except where necessary to correct an obvious error in the printed form. The blank spaces in the proposal form provided for each item must be filled in according to the requirements of the proposal form. The bidder must state the price written in ink or typed, both in words and numerals (if required), for which he proposes to do each item of the work contemplated, and the bidder shall make an extension of the total cost of the item which must be inserted at the place indicated in the proposal form. Where "no" dollars or "no" cents is part of the price bid, the word "no" and the numeral "0" shall be inserted in the appropriate spaces. Where a contract item is to be paid by the City-Parish or others, a price for this purpose will be preinserted in the schedule of items. In case of a conflict between written prices and prices in numerals, the written price shall govern. Should the written price be illegible, the price in numerals shall govern. Errors in unit price extensions will be corrected. The total bid amount will be the summation of the correct unit price extensions. Any revisions to bid prices shall be initialed by the bidder or the bidder's authorized representative.

The bidder shall sign the proposal and shall indicate the type of firm (individual, partnership or corporation) on the form provided. If the bidder is a corporation, a corporate resolution in the form provided must be included with the proposal.

For projects requiring a licensed contractor, the Louisiana State Contractor's License Number shall be entered on the bid envelope.

2-3 PROPOSAL GUARANTY: Each proposal must be accompanied by a certified check, cashier's check or bid bond acceptable to the City-

Parish in an amount equal to at least 5% of the proposal, payable without condition to the City--Parish as a guarantee that the bidder, if awarded the contract, will promptly execute such contract in accordance with the proposal and in a manner and form required by the contract documents and will furnish good and sufficient bond for faithful performance of the same.

When a bid bond is used, it shall be written by a surety company currently qualified to do business in Louisiana and currently on the U.S. Department of the Treasury Financial Management Service list of approved bonding companies published annually in the Federal Register, or by an insurance company currently qualified to do business in Louisiana with at least an A- rating in the latest printing of the A.M. Best's Key Rating Guide to write individual bonds up to 10% of policyholders' surplus as shown in the A.M. Best's Key Rating Guide.

The bid bond shall be countersigned by a person who is under contract with the surety company or bond issuer as an agent of the company or issuer, who is a licensed agent in Louisiana, and is residing in Louisiana.

2-4 IRREGULAR PROPOSALS: Proposals will be declared irregular or non-responsive for any of the following reasons and will not be considered:

- (a) The proposal does not have the prices written in ink or typed, both in words and numerals (if required), for which the bidder proposes to do each item of work, and an extension of the total cost of the item in the place provided.
- (b) The proposal does not have a total price for the entire contract in the place provided.
- (c) The proposal is submitted on altered or substitute forms.
- (d) The proposal is not signed by bidder.
- (e) The proposal is submitted as a bid by a bidder other than the one to whom the proposal was issued.
- (f) An owner or principal officer of the bidding firm is an owner or principal officer of a contracting firm which has been declared by the Department to be ineligible to bid.
- (g) Proposal guaranty does not meet requirements of Subsection 2-3.
- (h) Bidder fails to initial any revisions to the unit bid prices.
- (i) More than one proposal for the same work is submitted by an individual, firm or corporation under the same or different name.

(j) There is evidence of collusion among bidders. A participant in such collusion will receive no recognition as bidder for future work of the City-Parish until such participant has been reinstated as a qualified bidder.

(k) Bidder is in default of a City-Parish contract resulting in the contract currently being completed by others.

(l) Bidder has been disqualified in accordance with Subsection 9-4.1.

2-5 DELIVERY OF PROPOSALS: Each proposal should be submitted in a special sealed envelope furnished by the engineer, on which the bidder shall indicate the firm's name and address, bid opening date and time, project number and name, and Louisiana Contractor's license number (if licensed contractor is required). When an envelope other than the one furnished by the engineer is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. When sent by mail, the sealed proposal shall be addressed to the City-Parish at the address and in care of the Purchasing Director. Proposals shall be filed prior to the time and at the place specified in the notice inviting bids. Proposals received after the time for opening bids will be returned to bidder unopened.

2-6 WITHDRAWAL OR REVISION OF PROPOSALS

2-6.1 Before Bid Opening: A bidder may withdraw or revise a proposal after it has been deposited with the Purchasing Director provided the request for such withdrawal or revision is received by the Purchasing Director, in person or in writing or by telegram, before the time set for opening proposals.

2-6.2 After Bid Opening: A bidder may withdraw a proposal if it contains obvious, unintentional and substantial mechanical, clerical or mathematical errors; however, the request to withdraw the proposal and written evidence of the errors must be received by the Purchasing Director within 48 hours after bids are opened (excluding Saturdays, Sundays and holidays), and the written evidence must be sworn before a Notary Public as original, unaltered documents used in the bid preparation.

If the written evidence shows, to the satisfaction of the City-Parish, that such errors were made, the proposal may be withdrawn and the proposal guaranty will be returned to the bidder; however, the bidder will be disqualified from future bidding on the same contract and will not be approved as a subcontractor on the contract.

2-7 PUBLIC OPENING OF PROPOSALS: Proposals will be opened and read publicly at the time and place indicated in the notice inviting bids.

Upon opening all bids, bids will be checked for irregularities, then tabulated and forwarded to the department in charge of the work for review and recommendation.

Tabulation of all bids received shall be available for public inspection but shall not be considered final until reviewed and approved by the Purchasing Director and department concerned.

2-8 QUALIFICATIONS OF BIDDERS: The bidder must be qualified by experience, financing and equipment to do the work called for in the plans and specifications. When required, the bidder's construction experience and ability to perform the work contemplated shall be submitted with the proposal.

The Council shall have the right to take such action as deemed necessary in determining the ability of the bidder to perform the work satisfactorily, and to reject the bid of any bidder deemed to be unqualified to satisfactorily perform the proposed work.

Upon request of the engineer, a bidder whose bid is under consideration for award of a contract shall submit to the engineer satisfactory evidence of the bidder's financial resources, construction experience and organization available for performance of the proposed contract.

Bidders shall comply with State Licensing Laws for Contractors and shall require their subcontractors to comply with said laws.

2-9 EXAMINATION OF PLANS, SPECIFICATIONS AND WORK SITE: The bidder is expected to examine carefully the site of the proposed work, the proposal, plans, project specifications and contract forms before submitting a proposal. Submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to conditions to be encountered in performing the work and as to requirements of the plans, project specifications and contract forms.

The location, character and size of underground natural features and existing subsurface structures shown on the plans were obtained for use by the engineer in the preparation of design, and the City-Parish assumes no responsibility for the accuracy of such data.

2-9.1 Interpretation of Documents: A prospective bidder in doubt as to the meaning of any part of the plans, specifications or other proposed contract documents may submit to the engineer a written request for an interpretation thereof at least 7 working days prior to opening of bids. Interpretation of the proposed documents will be made by addenda issued before bidding in accordance with State law.

2-9.2 Site Conditions: When logs of test holes, ground water levels and any accompanying soil, geological or seismic reports are included in the plans or specifications, such data is furnished for information only. The field conditions so set forth shall not constitute a warranty that such conditions actually exist. Bidders should make their own investigations of the site conditions, both above and below ground.

2-10 QUANTITIES AND UNIT PRICES: The quantities for which unit prices are indicated in the proposal do not constitute a guarantee that the quantities so indicated are the actual quantities required for the work under the contract. The City-Parish reserves the right to increase or decrease the quantities of work and materials under unit price pay items as outlined in Subsection 4-2, provided said increase or decrease does not materially change the intent of the contract.

2-10.1 Approximate Quantities: The quantities in the bid schedule are approximate and will be used for comparison of bids, and the summation of the prices bid will determine the required amount of the proposal guaranty and surety bond.

Estimated quantities, if listed on drawings for any structure or item of work, are for the convenience of the contractor, and the City-Parish assumes no responsibility for their accuracy.

2-10.2 Changes in Estimated Quantities: Scheduled quantities of work to be done and materials to be furnished may be increased, decreased or omitted as herein provided, without invalidating the prices bid.

2-10.3 Actual Quantities: Payment to the contractor will be made only for the actual quantities of work performed and accepted, or materials furnished, in accordance with the contract.

2-10.4 Unit Prices or Lump Sum Pay Items: Work and materials, equipment and equipment rental will be paid for in accordance with the unit prices or lump sum pay items in the contract. If no pay item is provided for an item of work, material or equipment required under the contract, it will be considered as having been included in the prices bid for the pay items in the contract.

SECTION 3

AWARD AND EXECUTION OF CONTRACT

3-1 CONSIDERATION OF PROPOSALS: After proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule by the unit bid prices. The results of such comparisons will be immediately available to the public.

The right is reserved to reject proposals, to waive technicalities or to advertise for new proposals in accordance with State law.

3-2 AWARD OF CONTRACT: If the contract is awarded, the award will be made within 60 days after the opening of proposals to the lowest qualified bidder whose proposal complies with all requirements prescribed; however, the time for award may be extended by mutual agreement of City-Parish and said bidder. The successful bidder will be notified, by letter mailed to the address shown on the proposal, that the bidder has been awarded the contract

3-3 CANCELLATION OF AWARD: The Council reserves the right to cancel the award of a contract at any time before execution of said contract by all parties without liability against the City-Parish.

3-4 RETURN OF PROPOSAL GUARANTY: All checks submitted as proposal guaranties, except those of the 3 lowest bidders, will be returned following the opening and checking of proposals. The proposal guaranty checks of the 3 lowest bidders will be returned within 10 days after satisfactory bond has been furnished by the successful bidder and the contract executed.

3-5 EXECUTION OF CONTRACT: The contract shall be signed by the successful bidder and returned, with the contract bond and all other required documents, within 15 days after the contract has been received by the bidder. If the contract is not executed by the City-Parish within 45 days following receipt from the bidder of the signed contract and bond, the bidder shall have the right to withdraw the bid without penalty. No contract shall be considered as effective until it has been executed by all parties thereto.

3-6 FAILURE TO EXECUTE CONTRACT: Failure to execute the contract and file acceptable bond within 15 days after the contract has been received by the bidder shall be cause for cancellation of the award and forfeiture of the proposal guaranty which shall become the property of the City-Parish, not as a penalty, but in liquidation of damages sustained. Award may then be made to the next lowest responsible bidder or the work may be readvertised for bids, as the Council may decide.

3-7 SURETY BOND: Prior to execution of the contract, the contractor shall file with the Purchasing Director a surety bond on a form provided or approved by the City-Parish. The contractor shall pay all costs therefor.

The bond shall be written by a surety company qualified to do business in Louisiana and on the U.S. Department of the Treasury Financial Management Service list of approved bonding companies published annually in the Federal Register, or by an insurance company qualified to do business in Louisiana with at least an A- rating in the latest printing of A.M. Best's Key Rating Guide to write individual bonds up to 10% of policyholders' surplus as shown in A.M. Best's Key Rating Guide.

The bond shall be countersigned by a person who is under contract with the surety company or bond issuer as an agent of the company or issuer, who is a licensed agent in Louisiana, and is residing in Louisiana.

The bond shall be in effect at 100% of the contract amount until completion of the 1-year warranty period specified in Subsection 4-6 and until all claims for materials and labor are paid, subject to local ordinances and state lien laws.

The bond shall be so conditioned as to assure performance by the contractor of all work under said contract within the time limit prescribed in a manner satisfactory to the City-Parish; that materials and workmanship will be free from defects; and that should defects appear prior to completion of the 1-year warranty period specified in Subsection 4-6, the contractor shall make good such defects and make all replacements and adjustments required within a reasonable time after being notified by the Department to do so.

Should any surety become insufficient, the contractor shall renew said bond with good and sufficient sureties within 10 days after receiving notice from the City-Parish.

3-8 AFFIDAVIT: Prior to execution of the contract, the contractor shall file with the Purchasing Director an affidavit on a form provided by the Purchasing Director stating that the contractor has employed no person, corporation, firm, association or other organization to secure the public contract, other than persons regularly employed by the contractor whose services in connection with construction of the project or in securing the public contract were in regular course of their duties; and that no part of the contract price received was paid or will be paid to any person, corporation, firm, association or other organization for soliciting the contract, other than payment of normal compensation to persons regularly employed by the contractor whose services in connection with construction of the project were in regular course of their duties.

3-9 PROTESTS: The City-Parish will be responsible for resolution of protests of contract award, claims, disputes, alleged patent infringements, alleged license fees and related procurement matters. The following procedures shall be used for this purpose:

(a) Any party with direct financial interest adversely affected by the City-Parish's procurement decision may file a protest.

(b) A protest must (1) be in writing; (2) adequately state the basis of the protest and the relief requested; and (3) be received by the Purchasing Director within 7 days from the date the basis of the protest was, or should have been, known.

(c) The City-Parish will take action on protests within 45 days of the receipt thereof. The City-Parish may defer the protested procurement upon receipt of a procedurally adequate protest, or procurement of a sub-item may be permitted, at the City-Parish's discretion, where it will not materially affect resolution of the protest.

(d) A protest shall be limited to (1) issues arising from the procurement provisions of the contract and (2) state or local law.

(e) The City-Parish Attorney will establish procedures for resolution of protests. The City-Parish will rely, for resolution of the protest, on decisions issued under Louisiana law, as well as decisions issued by other states, Federal courts, the U.S. Comptroller General, or other Federal agencies with extensive procurement expertise, if Louisiana law is not clearly established.

SECTION 4

SCOPE OF WORK

4-1 INTENT OF CONTRACT: The intent of the contract is to provide for construction and completion in every detail of the work described. The contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

When an item in the contract contains a choice to be made by the contractor as to the type material to be furnished, the contractor, before the work is initiated, shall indicate the choice in writing to the engineer.

A Purchase Order will be issued for the contract for accounting and payment purposes. In case of conflict between the terms and conditions of the Purchase Order and the contract requirements, the contract requirements shall govern.

4-2 INCREASED OR DECREASED QUANTITIES: The City-Parish reserves the right to make such alterations in the plans or quantities of work as deemed necessary. Such alterations shall not be considered as a waiver of any conditions of the contract nor to invalidate any provisions thereof.

4-3 EXTRA WORK: Extra work made necessary by alteration of or additions to the plans, or by other reasons for which no price is provided in the contract, shall be performed by the contractor as directed in writing and payment therefor will be made as provided in Subsection 10-4.

If the engineer determines conditions to be such as to justify a claim for additional work, payment for the work in question shall be in accordance with a negotiated change order with the contractor. The contractor shall not be relieved, unless permitted to do so by the Department, from the obligation of resuming construction operations pending decision as to the validity of a claim or pending execution of a negotiated change order to cover additional costs if a claim is recognized under these provisions.

4-4 USE OF MATERIALS FOUND ON THE WORK: The contractor, with approval, may use in the proposed construction, stone, gravel, soil, sand or other material determined suitable by the engineer, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used, but shall replace at the contractor's expense with suitable material all material so removed which was needed for embankments, backfills, approaches or otherwise. The contractor shall not remove material from within the right-of-way which is not within grading limits without written authorization.

4-5 FINISHING AND CLEAN UP: From time to time or as ordered by the engineer, the contractor shall clean up and remove all refuse and unused materials resulting from the work. Upon failure to do so within 48 hours after written order by the engineer, the work may be done by the Department and the cost thereof deducted from payments for the work. Upon completion of the work, the contractor shall remove all materials not used in the work and all equipment and put the work area in a neat and clean condition satisfactory to the engineer.

4-6 WARRANTY: By signing the contract and providing a surety bond as specified in Subsection 3-7, the contractor guarantees all materials and workmanship provided under the contract for a period of 1 year after final acceptance.

Upon written notification the contractor shall promptly correct all work found to be defective during the 1-year period. If the contractor does not promptly comply with such instructions, or where delay would cause a risk of serious loss of injury, the City-Parish may have the defective work corrected, and all costs thereof shall be borne by the contractor or the contractor's surety.

SECTION 5

CONTROL OF WORK

5-1 SUPERVISION AND INSPECTION: The engineer shall have access to the work at all times. The contractor shall furnish all facilities for inspection at the construction site, shops or yards, and shall not cover up work requiring inspection until it has been approved. If work is covered up before being inspected, the contractor shall, at no additional payment, remove such portions of the work as necessary to disclose the part in question.

The contractor shall notify the engineer at least 24 hours prior to commencing any work, or resuming work after shut downs, except for normal resumption of work following Saturdays, Sundays or holidays.

The contractor shall provide proper supervision and sufficient labor and equipment to accomplish the work within the contract time.

The contractor shall have on the work at all times a superintendent capable of reading and understanding the plans and specifications and experienced in the type of work being performed, who shall receive instructions from the engineer. The superintendent shall have authority to execute orders of the engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as required.

The contractor shall maintain a telephone for the duration of the contract, at the contractor's expense, where the superintendent may be reached directly or by message at all times during and outside of working hours.

5-2 AUTHORITY OF THE DIRECTOR: The Director shall interpret all contract provisions, and such interpretation shall be binding on all parties to the contract.

5-3 AUTHORITY OF ENGINEER: The engineer shall decide all questions which arise as to the acceptability of materials furnished and work performed, progress of work, interpretation of plans and specifications, and acceptable fulfillment of the contract.

The engineer will have the authority to suspend the work wholly or in part due to failure of the contractor to carry out provisions of the contract; for failure to carry out orders; or for such periods deemed necessary due to unsuitable weather.

5-4 AUTHORITY AND DUTIES OF PROJECT ENGINEER: As the direct representative of the engineer, the Project Engineer has immediate charge of the engineering details of each construction project and is responsible for the administration and satisfactory completion of the project. The Project Engineer shall have the authority to reject defective materials and to suspend work that is being improperly performed until such work is corrected.

In no case shall the Project Engineer perform duties for or act as representative of the contractor.

5-5 DUTIES OF THE INSPECTOR: Inspectors employed by the City-Parish will be authorized to inspect all work done and materials furnished. Such inspection may extend to any part of work and to the preparation, fabrication or manufacture of materials to be used. The Inspector will not be authorized to issue instructions contrary to plans and specifications, or to act as foreman for the contractor.

5-6 WRITTEN NOTICES TO CONTRACTOR: Any written notice to the contractor from the Department relating to the contract shall be considered delivered and the service thereof completed when said notice is posted by registered mail, to the contractor at his last given address, or delivered in person to the contractor or the contractor's authorized representative on the work.

5-7 COORDINATION OF PLANS AND SPECIFICATIONS: The plans, specifications and other contract documents will govern the work to be done. Anything mentioned in the specifications and not shown on the plans, or shown on the plans and not mentioned in the specifications, shall be of like effect as though shown or mentioned in both.

Specifications and plans referred to in the contract documents shall be considered as being included in the document in which such reference is made. When a particular specification or standard is referred to, such reference shall be to the specification or standard, including officially adopted revisions and amendments thereto, which is in force at the time of advertising for bids.

In case of conflict, the order of preference of the following documents in controlling the work shall be: (1) Permits from outside agencies required by law: (2) Special Provisions, (3) Plans: (4) Standard Plans: (5) Standard Specifications.

Change orders and approved revisions to plans and specifications will take precedence over contract documents listed above.

5-8 PLANS AND SHOP DRAWINGS: The contractor will be furnished 5 sets of plans and specifications without charge.

The plans will show such details as necessary to indicate the proposed work and intended result. Any additional working drawings, detail plans or shop drawings required for the work shall be supplied by and at the expense of the contractor. All such drawings must be signed by the contractor.

When shop drawings are required or requested by the engineer, they shall be prepared in accordance with modern engineering practice. Shop drawings shall be submitted in quadruplicate to the engineer for approval or correction at least 30 days before approved drawings will be required. One set will be returned to contractor marked "approved" or "approved as corrected." If changes are required, 4 copies of corrected shop drawings shall be delivered to the engineer. Shop drawings shall be of sufficient size and scale to clearly show all details.

No materials shall be furnished or work done on items requiring shop drawings prior to approval.

Approval of shop drawings shall not relieve the contractor from responsibility for deviation from the contract documents unless the deviation was specifically called to the attention of the engineer, nor from responsibility for errors or omissions in the shop drawings.

The contractor shall keep on the work a copy of the plans and specifications and access thereto shall at all times be accorded the engineer.

5-8 SURVEYING

5-8.1 Permanent Survey Markers: The contractor shall be responsible for the preservation of public and private property and shall protect from disturbance and damage all land monuments, property line markers, or horizontal and vertical control monuments such as those established by the United States Coast and Geodetic Survey, National Geodetic Survey, Louisiana Geodetic Survey, City-Parish DPW, Louisiana DOTD, Corps of Engineers, or United States Geological Survey.

Before removing and resetting any survey monuments, the contractor shall give sufficient advance notice, in writing, to the appropriate agency responsible for the monument and to the engineer of the intention to perform the work so that such agency may have a representative present if it so desires. The contractor shall not disturb or move any such monument without approval. The engineer will designate the location and manner in which these monuments are to be reset.

The contractor shall be responsible for all damage to markers or monuments during the work due to negligent act, omission or misconduct in executing the work, or due to defective work, equipment, or materials. This responsibility will not end until final acceptance.

5-8.2 Lost or Disturbed Stakes: The contractor shall preserve existing survey stakes that mark property lines and corners.

Stakes that become lost or disturbed by the contractor's operation shall be replaced at the contractor's expense by a Registered Land Surveyor.

5-8.3 Survey Service: The engineer will establish only the necessary horizontal and vertical control points required to control the work. All other surveying required to lay out the work and perform the required construction staking shall be the responsibility of the contractor.

The contractor shall employ qualified personnel, experienced in construction layout surveying, and shall furnish all stakes, templates and equipment required to perform the survey work. The contractor shall be responsible for proper execution of the work to lines and grades shown on the plans or established by the engineer.

The contractor shall preserve and be responsible for re-establishing any points which are disturbed.

The engineer may make checks on construction alignment and grades to determine the correctness of the survey work; however, these checks will not relieve the contractor of his responsibility for constructing the work in the positions and to elevations shown on the plans or established by the engineer.

Measurements for determination of pay quantities will be made by the engineer.

No direct payment will be made for providing the required surveying and staking of lines and grades for the work.

5-8.4 Line and Grade: All work shall conform to the lines, elevations and grades shown on the plans. Distances and measurements, except elevations and structural dimensions, are given and made on horizontal planes.

5-9 COOPERATION BY CONTRACTOR: The Council may let other contracts for and perform additional work on or near the work covered by the contract.

When separate contracts are let within, adjoining, or adjacent to the limits of the project, each contractor shall conduct the work so as not to hinder the progress of work by other contractors and shall cooperate with each other as directed.

The contractor shall arrange the work and shall place and dispose of materials being used so as not to interfere with the operation of other contractors within, adjoining, or adjacent to the project. The contractor shall acceptably join the work with that of other contractors and shall perform the work in proper sequence to that of the others without causing disruption or delay to the schedule of project completion.

Where practical, utility owners responsible for facilities located within the right-of-way will be required to complete any installation, relocation, repair or replacement prior to commencement of work by the contractor. However, when this is not feasible or the need for such work was not foreseen, such utility owners shall have the right to enter upon the right-of-way and upon any structure therein for the purpose of making new installations, changes or repair, and the contractor's operations shall be so conducted as to provide the time needed for such work to be accomplished during progress of the improvement.

5-10 LOAD RESTRICTIONS: The contractor shall comply with legal load restrictions, including local ordinances, in hauling materials on public roads beyond the project limits. A special permit will not relieve the contractor of liability for damage due to moving of equipment and materials.

The operation of equipment of such weight or so loaded as to cause damage to drainage structures, roadway or other type of construction or reconstruction, completed or uncompleted, will not be permitted. Hauling of materials over subbase and base course under construction shall be limited as directed. No loads will be permitted on a concrete pavement or structures until the concrete has developed the specified strength. The contractor shall be responsible for damage resulting from his operations.

5-11 EXISTING STRUCTURES AND UTILITIES: The plans show the location of all known surface and subsurface structures and utilities. The Department assumes no responsibility for failure to show the existence or the exact location of these structures or utilities on the plans and such failure will not be considered basis for additional compensation.

The contractor shall provide suitable temporary channels for all water courses and shall hold the City-Parish harmless against all claims for damages due to obstructions to the flow of sewers, drains, ditches or gutters, or because of damage to water, oil, gas or other pipes or conduits. The contractor shall also hold the City-Parish harmless against all claims for damages due to damage to electric, telegraph, telephone, or similar structures or to buildings, bridges, fences, walls, poles, supports, etc.

The contractor shall be responsible for poles, posts, supports or other structures or objects existing along the line of his work, shoring up or supporting them when necessary. The contractor shall shore up and otherwise protect any building or structure which may be endangered during the work and shall restore to the same condition as existed previous to the work, all bridges, buildings, fences, walls or other properties disturbed or damaged due to the contractor's work, all without direct payment.

The contractor shall be responsible for the cost of repairing any damage to utility structures or lines due to the contractor's operations where the existence and approximate location of the facility has been made known to the contractor prior to working in the immediate vicinity. Water, oil or gas pipe lines, drains, conduits or other structures which are encountered and do not, in the opinion of the engineer, require relocation or adjustment to perform the work under contract, shall be supported and protected from damage by the contractor and if damaged or removed they shall be restored at the contractor's expense to a condition as good as that in which they were found. If it is necessary to change or move the property of any private owner, such property shall not be moved or interfered with until so ordered. The right is reserved to the property owner to enter the work area for the purpose of making such changes or repairs to their property as necessary for performance of the contract.

5-12 UNACCEPTABLE AND UNAUTHORIZED WORK: Work not conforming to the requirements of the contract will be considered as unacceptable work.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness or other cause, found to exist prior to completion of the 1-year warranty period specified in Subsection 4-6 shall be removed and replaced in an acceptable manner.

Work done contrary to instructions of the engineer or beyond the lines shown on the plans or as instructed, except as herein specified, or extra work done without written authority will be considered as unauthorized and will not be paid for. Work so done may be ordered removed or replaced at the contractor's expense.

5-13 MAINTENANCE OF WORK: The contractor shall maintain the work during construction and until final acceptance and no direct payment will be made therefor. This maintenance shall constitute continuous and effective work, prosecuted as required, with adequate equipment and force, to the end that the project is kept in satisfactory condition at all times.

Particular attention shall be given to drainage, both permanent and temporary.

The contractor shall use all possible precautionary measures to avoid damage or loss that might result from accumulations and concentrations of drainage waters, and material carried by such waters, and such drainage shall be diverted or dispersed when necessary to prevent damage to excavation, embankments, surfacing, structures or property. Where adequate outfalls are not available, the contractor shall bear the cost of pumping water until the work is completed and accepted.

If the contractor's work is ordered suspended, the contractor shall maintain the work as provided herein, and provide such ingress and egress for local residents as necessary during the period of suspended work or until the contract has been declared in default. Failure of the contractor to maintain the work satisfactorily will result in the engineer immediately notifying the contractor to comply with the required maintenance provisions. If the contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the engineer may perform the maintenance work and deduct the cost thereof from payments for the work.

5-14 ACCEPTANCE OF WORK

5-14.1 Partial Acceptance: When any portion of the work is completed and its use is required by the City-Parish, the contractor, upon receipt of a written order from the engineer, will be relieved of the duty of maintaining and protecting such portions of the work which are ready to be placed in service and which have been completed in accordance with the plans and specifications.

Such order by the engineer will relieve the contractor of responsibility for damage to said completed portions of the improvement except damage due to the contractor's operations or negligence. The contractor will not be required to again clean up

such portions of the improvement prior to final acceptance, except for such items of work as result from the contractor's operations. However, nothing in this section shall be construed as relieving the contractor from responsibility for making good defective work or materials.

5-14.2 Final Acceptance: When all work under the contract has been satisfactorily completed, the engineer will submit a Certificate of Final Completion to the Council for final acceptance.

5-14.3 Claims for Adjustment and Disputes: If the contractor deems extra compensation is due for work or materials not covered in the contract, or not ordered by the engineer as an extra, the contractor shall notify the engineer in writing of his intention to make claim for such extra compensation before beginning the work on which the claim is based and shall afford the engineer every facility for keeping cost of the work or provide the engineer with a daily accounting. Failure of the contractor to give such notification or to afford the engineer proper facilities for keeping account of cost shall constitute a waiver of the claim for extra compensation. The filing of such notice by the contractor and the keeping of costs by the engineer shall not be construed to prove the validity of the claim. When the extra work has been completed, the contractor shall within 10 days file a claim for extra compensation with the engineer along with all supporting documentation evidencing every item of cost; every item not claimed is deemed waived. Where a claim covers a period in excess of a single pay period, the foregoing accounting of costs shall be submitted with each pay request. If the claim, after consideration by the Director, is found to be just, payment will be made in accordance with Subsection 10-4.

SECTION 6

CONTROL OF MATERIALS

6-1 SOURCE OF SUPPLY AND QUALITY: Materials used in the work shall meet all quality requirements of the contract. To expedite inspection and testing of materials, the contractor shall notify the engineer of the proposed sources of materials prior to delivery. At the option of the engineer, materials not listed in the QPL may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the contractor shall furnish materials from other sources or make necessary changes to provide acceptable materials.

6-2 FURNISHING OF MATERIALS: The contractor shall furnish all materials required to complete the work, except those specified to be furnished by the City-Parish.

Material furnished by the City-Parish will be delivered or made available to the contractor at the points specified.

The cost of handling and placing materials after they are delivered to the contractor shall be considered as included in the contract price for the item for which they are used.

The contractor will be responsible for all material delivered, and deductions will be made from payments for the work to make good any shortages and deficiencies, and for any damage which occurs after such delivery, and for any demurrage charges.

6-3 SUBSTITUTIONS OF MATERIALS OR EQUIPMENT: When a particular material, process or equipment is specified by patent, proprietary or brand name, or by name of manufacturer, such wording shall be deemed to be used for the purpose of facilitating description of the material, process or equipment desired, and shall be deemed to be followed by the words "or equal". Lists of acceptable materials indicated in the plans or specifications are not intended to be comprehensive lists, or in any order of preference. The contractor may offer any material, process or equipment which complies with the specifications and which the contractor considers equal to that specified.

Any proposed substitution shall include the cost of any necessary changes in the project to substitute the proposed equipment, material or product for a complete installation.

If a substitute offered by the contractor is not found by the engineer to be equal to the material specified, the contractor shall furnish and install the material specified.

The contractor shall, before installation, submit data substantiating a request for a substitution of "an equal" item. The contractor shall furnish information or data concerning the material

or equipment offered as an equivalent to that specified; and if required, the contractor shall have the material tested for quality, strength, physical, chemical or other pertinent characteristics, including durability, finish, efficiency, dimensions, service and suitability to perform the function intended. No direct payment will be made for such submittals and testing.

The method of performing the tests shall be subject to approval and the results of said tests shall be reported to the engineer, who will evaluate the results and determine whether or not the substitute material or equipment is deemed to be equivalent, and the engineer's findings shall be final. Installation and use of the material shall not be made until such substitute material has been approved.

The time specified for completion of the work under the contract shall not be affected by any circumstances developing from the provisions of this section.

6-4 MATERIALS AND WORKMANSHIP: Materials, parts and equipment furnished by the contractor shall be new and free from defects. Workmanship shall be in accordance with the best standard practices. Materials and workmanship shall be subject to approval.

Manufactured products shall bear identifying product marking, and a manufacturer's certification shall be furnished to the engineer stating that such products conform to plans and specifications.

Materials and workmanship not conforming to specifications shall be considered as defective and will be rejected. Defective material shall be removed from the site by the contractor at the contractor's expense when directed. No rejected material, the defects of which have been corrected, shall be used without approval.

If the engineer determines that a defect in material or workmanship is not of such consequence as to result in a dangerous or undesirable condition, or that removal of such work would create a dangerous or undesirable condition, the City-Parish shall have the right to retain such work and make such deductions in the payment therefor determined reasonable and in the public interest.

6-5 TESTS OF MATERIALS: Testing required by the City-Parish to determine quality, fitness and suitability of materials shall be performed at the direction and upon the order of the engineer, and at no expense to the contractor, except as provided in Subsection 6-6. Where tests prove that materials do not meet the specified requirements, and retests are required for this reason, the cost for such retests shall be borne by the contractor. Samples of materials may be secured and tested when considered necessary by the engineer.

The contractor shall deliver materials for testing at the time and to the place designated and no direct payment will be made therefor.

6-6 INSPECTION AT SOURCE: At the Department's option, materials and equipment may be inspected at the source or place of manufacture. The contractor and producer shall cooperate with and assist the engineer during such inspections, and afford the engineer plant access at all times during work hours.

The cost of tests or inspections made at plants or sources located outside East Baton Rouge Parish shall be borne by the contractor.

The engineer reserves the right to retest equipment and materials which have been tested and accepted at the source of supply after they have been delivered and to reject materials and equipment which when retested do not meet specifications.

6-7 LIST OF MATERIALS AND EQUIPMENT: If required, the contractor shall submit within 30 days after signing the contract, to the engineer a list of all materials and equipment ordered for the project, the manufacturers or agents from whom ordered, catalog and type number, quantity ordered and promised delivery date on each item. Any subsequent changes in equipment and materials, manufacturer's type, quantity or delivery dates shall be promptly brought to the attention of the engineer. Shipping notices shall be furnished in adequate time prior to delivery so that provisions for inspection on receipt can be made.

6-8 STORAGE OF MATERIALS AND EQUIPMENT: Materials and equipment shall be stored so as to insure preservation of their fitness for the work, and in a manner that leaves the material and equipment accessible to inspectors. Storage shall not interfere with the prosecution of the work or with public travel.

6-9 HANDLING MATERIALS AND EQUIPMENT: Materials and equipment shall be handled in such manner as to preserve their quality and fitness for the work. They shall be transported to the work in vehicles so constructed as to prevent loss or breakage of materials. Damaged materials or equipment will be subject to repair or rejection.

6-10 POWER, WATER, AND FUEL: The contractor shall provide all power, water and fuel required for his operations and shall make arrangement with the utility company for supplying such service, the terms and rates to be charged, and payment for same.

The contractor shall not interfere with or attach a connection to any supply or service line of a utility unless authorized to do so by the utility.

SECTION 7

LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

7-1 LAWS TO BE OBSERVED: The contractor shall keep informed of and comply with Federal and State Laws, local bylaws, ordinances and regulations, and orders and decrees of bodies or tribunals having jurisdiction or authority, which affect those employed on the work or the conduct of the work. The contractor shall indemnify the City-Parish and its representatives against any claim arising from violation of any law, ordinance, regulation, order or decree by the contractor or the contractor's employees.

7-1.1 Taxes, Permits, Certificates and Licenses: Federal, State and Local taxes due on materials, equipment or labor in connection with the work must be included in the amount bid by the contractor and shall be paid to proper authorities before acceptance. Except for permits relating to railroad and highway crossings, the contractor shall procure all necessary permits, licenses and certificates, pay all charges and fees, and give all notices incident to lawful prosecution of the work.

7-1.2 Patented Devices, Materials, and Processes: If the contractor is required or desires to use any design, device, material or process covered by patent or copyright, the contractor shall provide for such use by legal agreement with the patentee or owner, and a copy of this agreement shall be filed with the engineer. The contractor and the surety shall indemnify the City-Parish from all suits, costs, penalties or claims for infringement due to use of such patented design, device, material or process, or any trademark or copyright in connection with the work.

7-2 INSURANCE: The contractor shall provide, and maintain until final acceptance of the work, insurance described herein with an insurance company that has an industry rating of at least B+, Class VI, according to Best's Key Rating Guide. Certificates showing such insurance is in effect shall be furnished to the City-Parish Purchasing Director prior to execution of the contract, which certificates shall incorporate a provision that no cancellation or change in such insurance shall be effected without at least 30 days prior written notice being given to the Purchasing Director.

- I. Standard Workmen's Compensation - Full statutory liability for State of Louisiana with Employer's Liability Coverage of \$100,000 minimum per occurrence.
- II. Comprehensive General Liability - Combined BI & PD \$1,000,000*

Coverage Required:

- A. Premises Operations
- B. Contractor's Protective Liability
- C. Products-Completed Operations

- D. Contractual Liability
- E. Broad Form Property Damage
- F. Explosion, Collapse and Underground Coverage (This coverage may be waived if project does not require same.)

III. Business Auto Policy - Combined BI & PD \$1,000,000*

- A. Owned
- B. Non-Owned
- C. Hired

* These requirements shall not be construed to limit the obligations of indemnity and defense of the contractor, but constitutes a minimum insurance requirement which must be provided to secure such obligations.

- IV. Umbrella Liability: Lower primary limits will be accepted if Umbrella Coverage is provided with limits of at least \$1,000,000 in excess of primary coverage shown on the certificate.
- V. The City of Baton Rouge, Parish of East Baton Rouge shall be named on all liability policies described above as additional insureds.
- VI. Waiver of subrogation in favor of the City of Baton Rouge, Parish of East Baton Rouge, is required from Worker's Compensation insurer.
- VII. The certificate holder shall be listed as follows:

City of Baton Rouge, Parish of East Baton Rouge
Attn: Purchasing Division
Post Office Box 1471
Baton Rouge, Louisiana 70821

- VIII. Incomplete Construction: The City-Parish assumes no risk for loss by fire or other casualty to a portion of the project or equipment thereof, whether complete, in process of construction or installation, or stored on the premises, during the life of contract for any portion of the construction except that the contractor shall not be responsible for loss by fire or other casualty to such portions of the work which the City-Parish is using unless damage occurs as a result of negligence by the contractor or as a result of work not completed by the contractor.

Making of partial payments to the contractor shall not be construed as creation of an insurable interest by or for the City-Parish or as relieving the contractors or their sureties of responsibility for loss from all risks (fire, windstorm, explosion, vandalism, flood, etc.) occurring prior to final acceptance of the project

7-3 FEDERAL AID PROVISIONS: When the United States Government pays a portion of the cost of a project, Federal laws and rules and regulations made pursuant to such laws must be observed by the contractor, and the work shall be subject to inspection of the appropriate Federal agency. Such inspection shall not make the Federal Government a party to this contract and will not interfere with the rights of either party hereunder. Any provisions in the contract documents, including these specifications, which are in conflict with the General Conditions required by the U.S. Government shall be void.

7-4 PUBLIC CONVENIENCE AND SAFETY: Except as otherwise provided herein, the contractor shall provide for and maintain local traffic at all times. Convenience of the public and protection of persons and property shall be adequately provided for by the contractor.

When the amount of traffic and condition of the street or road are such that dust on street or road surfaces constitutes a safety hazard or gross public inconvenience, the contractor shall take proper measures for dust control.

Materials stored about the work shall be so placed and the work shall be so conducted as to cause the least obstruction to traffic. The contractor shall make provisions by bridges or otherwise at cross streets, roads, sidewalks and driveways for passage of pedestrians and vehicles, provided that where bridging is impractical or unnecessary, the contractor may make arrangements for diversion of traffic and shall, at the contractor's expense, provide all material and perform all work necessary for construction and maintenance of roadways and bridges for diversion of traffic.

Sidewalks must not be obstructed. Materials excavated, construction materials, or plant used in the construction shall be placed so as not to endanger the work or prevent access to fire hydrants, water valves, gas valves, manholes for telephone, telegraph, signal or electric conduits, sanitary or storm sewers, and fire alarm or police call boxes.

Where the contractor is required to construct temporary bridges or make other arrangements for crossing over ditches or streams, the contractor's responsibility for accidents shall include the roadway approaches as well as the structures of such crossings.

The contractor shall maintain and operate equipment to minimize noise. Engines shall be equipped with properly functioning mufflers. The contractor shall limit activity near noise sensitive areas, such as churches, hospitals and schools, so normal activities are not unduly disrupted.

7-4.1 Maintenance of Traffic: Traffic shall be maintained to the extent practical during construction and residents or businesses must not be denied access to their property except when the nature of the work requires closing of the street. The street shall be left open to a maximum extent for collection of garbage, etc. It is not deemed practical to maintain traffic continuously or during all phases of construction and no attempt will be made to do so when the available right-of-way is needed by the contractor for proper prosecution of the work. The contractor shall render the road passable to property owners, postal services and city services when construction operations do not interfere with use of the street. The contractor shall do everything practical to provide access to abutting properties for essential services. Cutting of streets for cross pipe, culverts, etc., shall be done in such manner as to avoid blockage of access to abutting property except for compelling reasons.

7-4.2 Closing of Streets: At least 2 days before closing a street to traffic or at least 2 days before beginning work that will block traffic, the contractor shall notify in writing the Fire Chief, Traffic Engineer and Police Department having jurisdiction in the area, with copies of such notifications being sent to the engineer. Upon re-opening the street to traffic, the above mentioned officials should be notified to that effect in writing. The contractor shall notify residents and business owners before commencing work which will block access to their property. Access must be restored as soon as possible.

7-4.3 Barricades, Signs, Lights and Watchmen: Where work is performed on or adjacent to a street, alley, school yard or other public place, the contractor shall furnish and erect barricades, fences, lights and danger signals, shall provide watchmen, and shall take other precautionary measures as necessary for protection of persons or property and the work. From sunset to sunrise, the contractor shall furnish and maintain at least one light at each barricade and a sufficient number of barricades shall be erected to keep vehicles from being driven on or into any work under construction. The contractor shall furnish watchmen in sufficient numbers to protect the work. Where a street or highway is closed to traffic, the contractor shall provide and maintain warning and detour signs at all closures, intersections and along detours directing traffic around closed portions of the street or highway.

All barricades and obstructions shall be illuminated at night and all lights kept burning from sunset to sunrise. Barricades shall be equipped with reflector buttons, discs, scotchlite or other light reflecting material satisfactory to the engineer.

Barricades, signs, lights and other warning devices shall conform to the MUTCD.

The contractor will be responsible for damage to the work due to failure of barricades, signs, lights and watchmen to protect it, and when evidence is found of such damage, the engineer may order the damaged portion removed and replaced by the contractor. The contractor's responsibility for maintenance of barricades, signs and lights and for providing watchmen shall not cease until the work has been completed and accepted.

7-4.4 Use of Explosives: The use of explosives will be permitted only when authorized in writing by the engineer.

7-4.5 Truck Bed Covers: Trucks or other conveyances hauling loose materials on public streets, highways or detours shall be covered to prevent such materials from dropping, sifting, leaking or otherwise escaping therefrom. Covering for trucks or other conveyances shall be securely fastened so as to prevent said covering from becoming loose, detached or in any manner a hazard to traffic.

7-5 WORK IN, AND USE OF STREETS, SERVITUDES AND RIGHTS-OF-WAY: For performance of the contract, the contractor will be permitted to occupy such portions of streets, alleys, or public places or other rights-of-way or servitudes as provided for by local ordinances, as shown on the plans, or as permitted.

7-5.1 Work in State Highway Rights-of-Way: Where State Highway rights-of-way are encroached upon or intersected by the work, permission will be obtained from the DOTD with regard to methods of construction, materials and safeguards.

7-5.2 Work In Servitude Over Private Property: Where the work passes over or through private property the City-Parish will provide such right-of-way by servitude agreements. Servitude agreements will provide for temporary use of adjacent property for construction purposes. The contractor shall notify the owner of each property over which the work will pass at least 48 hours in advance of any work on said property and arrange for access. Where fences must be removed for construction purposes or access they shall be reconstructed or replaced. The contractor shall provide adequate gates to contain or restrict farm animals within their proper areas during the work and shall provide access where and when required. The contractor shall not remove or cut trees or shrubs without proper authority.

7-5.3 Preservation and Restoration of Property: The contractor shall protect public and private property and shall take reasonable precaution to avoid damage to such property.

Public or private improvements or facilities within the right-of-way not designated for removal but visibly evident or correctly shown on the plans which are damaged due to the contractor's operations shall be restored by the contractor at the contractor's expense to a condition equal to that existing before such damage, by repairing or rebuilding, or if this is not feasible, a reasonable settlement shall be made with the owner of the damaged property.

Except for emergency projects, the contractor shall give at least 14 days notice to occupants of buildings on property adjacent to the work to permit occupants to salvage or relocate plants, trees, fences, sprinkler systems, signs or other improvement in the right-of-way which are designated for removal or which might be damaged by the contractor's operation.

The contractor shall not be responsible for protection of planted areas within the right-of-way except for trees not designated for removal but shall conduct operations so as to minimize damage to such planted areas.

The contractor shall not trespass on private property and shall take precautions to protect public and private property from damage. The contractor shall restore any public or private property damaged due to the contractor's operations to a condition equal to that existing before damage. If the contractor fails to do so, or refuses to do so upon notice, the Department may cause such restoration and deduct costs from payments to the contractor.

7-5.4 Right-of-Way: The right-of-way for the improvement will be provided by the City-Parish. The contractor shall make arrangements and pay all expenses for additional area required outside the right-of-way.

7-6 WORK ON RAILWAY PROPERTY: Where the work encroaches upon the right-of-way of a railway, the contractor shall observe regulations and instructions of the railway company as to methods of doing the work, or precautions for safety of property and the public. All negotiations with the railway company, except for easement and permit, shall be made by the contractor. The railway company shall be notified by the contractor at least 5 days prior to beginning work on the railroad right-of-way.

The provisions given elsewhere herein, which require the contractor to protect property against damage, and which place upon the contractor all responsibility for damage to property, injury to persons, and loss, expense, inconvenience and delay to the owners of property and others, shall apply in connection with railway property. In the protection of railroads, however, the contractor shall exercise particular care to avoid damage which might result in train wrecks or delays in train service. In the performance of work in close proximity to railroad tracks, the contractor shall consult with railroad officials in regard to methods of conducting the work, and shall use in the performance of the work methods which are satisfactory to said officials, and he shall at no direct pay provide such trackwalkers and flagmen as officials deem necessary for protection of railroad property and train service.

The contractor shall assume the risk of, defend and indemnify the railway company, its officers, directors, employees, agents, successors and assigns against claims, demands, losses, damages and liabilities which arise in connection with the construction; provided, however that no such defense of indemnity shall be owned with respect to any injury or damage due to the willful misconduct of the railway company, its officers, agents or employees. During the period of construction, the contractor shall provide contractual and comprehensive general liability insurance, including personal injury and public liability and property damage coverage, and Railroad Protection Liability with a minimum combined single limit of

liability of \$6,000,000. Certificates of insurance shall be provided to the railway company and the engineer evidencing such insurance coverage. The insurance policies shall name the railway company as an additional insured and shall provide that the insurance shall not be canceled or materially changed unless 15 working days notice is given to the railway company.

7-7 PREVENTION OF SOIL EROSION AND WATER POLLUTION: The contractor shall protect the project and adjoining properties from soil erosion and siltation by effective and continuous erosion control methods and shall comply with the requirements of Subsection 903-3.1. Areas of soil exposed by construction operations shall be kept to a minimum.

7-8 RESPONSIBILITY FOR DAMAGE CLAIMS: The contractor shall indemnify the City-Parish, its officers and employees from all suits, actions or claims brought because of injuries or damage sustained by any person or property due to negligent operations of the contractor; due to negligence in safeguarding the work; or use of unacceptable materials in constructing the work; or any negligent act, omission or misconduct of the contractor; or claims or amount recovered from infringements of patent, trademark or copyright; or from claims or amounts arising or recovered under the Workmen's Compensation Act or other law, ordinance, order or decree.

7-8.1 Contractor's Responsibility: Until final acceptance of the project by the Council, the contractor shall have the charge and care thereof and shall take every precaution against damage to any part thereof. The contractor shall rebuild, repair, restore or make good all damages to the work before final acceptance and shall bear the expense thereof.

7-8.2 No Waiver of Legal Rights: Upon completion of the work, the City-Parish will make final inspection and notify the contractor of acceptance. Such final acceptance shall not prevent the City-Parish from correcting any measurement, estimate or certificate made before or after completion of the work, nor shall the City-Parish be prevented from recovering from the contractor or surety, or both, such overpayment it may sustain by failure of the contractor to fulfill obligations under the contract. A waiver by the City-Parish of any breach of any part of the contract shall not be a waiver of any other breach.

The contractor shall be liable to the City-Parish for latent defects, fraud or such mistakes as amount to fraud, or as regards the City-Parish's rights under any warranty or guaranty.

SECTION 8

UTILITIES

8-1 GENERAL: Utilities for the purpose of these specifications shall be considered as including but not limited to pipe lines, conduits, cables, transmission lines and appurtenances of Public Utilities and those of Special Utility Districts, Cities or Towns, businesses or individuals solely for their own use or for use of their tenants, and storm drains, sanitary sewers, street lighting, traffic signal and fire alarm systems, except those owned or under direct control of the City-Parish.

Except as indicated in Subsection 8-4.4, the removal, adjusting, relocation or replacement of utility structures or facilities within the right-of-way necessary for construction of work being done for the City-Parish shall be at the expense of the utility owners.

8-2 PRIOR PLANNING: Prior to advertisement of the work, the City-Parish and known utility owners affected by the work will exchange information which provides, on the part of the utility, the location of all known facilities within the right-of-way and avoidance of these utilities by design of the work by the City-Parish, where feasible. The City-Parish shall not be responsible for the accuracy of locations so designated by the utility owner.

8-3 NOTIFICATION: When the work is advertised for bidding, the known owners of all utilities affected will be notified by the engineer and provided with plans of the improvements. This notification will generally allow sufficient time for removal, adjustment or relocation of facilities prior to construction. When, in the opinion of the engineer, utility work necessitates more time than normal notification would allow, additional time shall be given to perform the work, either through prior notification or through a delay in commencement of the project work. Utility work which, in the opinion of the engineer, may be done more feasibly in conjunction with the construction work may be allowed and scheduling of such work shall be approved by the engineer and cooperation of the contractor will be required.

While it is the utility owner's responsibility to perform any work and bear any expense involved in utility relocations and adjustments, it shall be the contractor's responsibility to protect those utilities which do not need to be disturbed to accomplish the work.

8-4 COOPERATION WITH UTILITIES: After the contractor is issued the Notice to Proceed, the engineer will notify utility companies of the time, date and place of the preconstruction meeting, at which meeting a copy of the contractor's approved progress schedule will be made available to the utility company.

If changes in the schedule occur, the contractor shall notify the owner of the utility affected so that adjustments in the work schedule of the utility can be made. The contractor shall be responsible for damages to utility facilities and construction delays resulting from failure to notify the utility of changes in procedure or location.

Locations of construction work, including lines and grades, to be performed on the project where utilities are in conflict or in close proximity to the work will be shown the utility owner and staked by the contractor. The utility owner shall protect the stakes to prevent duplication of work. The utility owner shall be responsible for accurately staking adjustments to utilities.

In case of interruption to utility service as result of accidental breakage, or as a result of being exposed or unsupported, the contractor shall promptly notify the proper utility company or authority. The contractor shall cooperate with the utility company or authority in restoration of service as promptly as possible. If necessary, the contractor shall remain on the job to assist in restoration of interrupted utility service.

8-4.1 Abandoned Utilities: Utilities shown on the plans to be abandoned which interfere with construction shall be removed by the contractor. If no provision is made for separate payment, the cost of such removal shall be included in the price bid for other items. If specified or directed, a utility owner may salvage abandoned facilities. The engineer shall require the utility owner to make repairs to the area of salvage if the area is not in as good condition as existed prior to the salvage operation.

8-4.2 Utilities Not Within Working Limits: Protection of utility facilities which are located within the right-of-way, but outside the limits of construction determined by the engineer, shall be the responsibility of the contractor. The contractor shall be responsible for damage to utilities due to the contractor's negligence.

8-4.3 Utilities To Be Adjusted: Owners of utility facilities which require relocation, removal or adjustment shall, if possible, perform this work prior to commencement of the contractor's work. Where utility work must be done in conjunction with the contractor's work or the work of other utilities, arrangements for when, how and where the operation is to proceed shall be worked out among the parties concerned.

8-4.4 Utilities Conflicting With Operations: Utility facilities which do not conflict with the improvement, but which are obstructions to operations required for installation or which present unusual difficulty due to their close proximity to the area of operation shall be located by utility owners prior to commencement of the contractor's operation which would be hindered by the utility facility. The contractor shall preserve the utility facility in place without damage and shall be responsible for damages sustained if the utility owner has located the facility by exposing it to view or has otherwise shown the contractor the location of the facility.

8-4.5 Mislocated Utilities: The utility owner shall be responsible for proper location of its facilities which are affected

by construction work. Improperly located or mislocated facilities which are damaged during construction shall be the responsibility of the utility, providing notification according to Subsection 8-3 has been given.

8-5 WORK BY UTILITIES: Excavation and backfill work done by utility owners on projects for the City-Parish shall be performed to the same standard as required of the contractor for installation of similar items.

SECTION 9

PROSECUTION AND PROGRESS OF WORK

9-1 SUBLETTING OF CONTRACT: With written permission of the Director, the contractor may sublet all items of work designated in the contract as "Specialty Items" and not more than 50% of the remaining contract amount. No subcontractor shall sublet any portion of the authorized work without written permission of the contractor and the Director.

No subcontract will relieve the contractor of his responsibility under the contract and bond. The contractor will be as responsible to the City-Parish for acts and omissions of the subcontractor and of persons employed by the subcontractor as for the acts and omissions of persons employed by the contractor. All transactions of the engineer will be with the contractor. Subcontractors will be considered only in the capacity of employees or workmen and shall be subject to the same requirements as to character and competency.

9-2 NOTICE TO PROCEED: No work shall be performed on a project until the Director has issued a written Notice to Proceed. The Notice to Proceed will stipulate the date on which the contractor shall begin work, which date shall be the beginning of contract time charges.

9-3 PROGRESS SCHEDULE: Prior to beginning work the contractor shall submit to the project engineer a construction progress schedule giving a schedule of operations that provides for completion of work within the contract time. This schedule shall be in bar graph form. The contractor shall have copies of the schedule available at the preconstruction meeting.

If the contractor's operations are affected by changes in the plans or amount of work, or if the contractor has failed to comply with the original schedule, the contractor shall submit a revised construction progress schedule. This revised schedule shall show how the contractor proposes to prosecute the balance of the work. The contractor shall submit the revised schedule within 14 days after being requested by the engineer or progress payments may be withheld.

The approved construction progress schedule will be used as the basis of establishing the controlling item of work and as a check on the progress of the work. The construction progress schedule shall show only one controlling item of work for each day.

9-4 PROSECUTION OF WORK: The work shall be conducted in such manner as to insure its completion within the contract time.

If prosecution of work is discontinued, the contractor shall notify the engineer at least 24 hours in advance of resuming operations.

9-4.1 Disqualification: The contractor's progress will be determined monthly at the time of each partial estimate, and will be based on the total amount earned by the contractor as reflected by the partial estimate. If the contractor's progress is more than 20% behind elapsed

contract time, the contractor will be notified that disqualification will occur if progress becomes delinquent by more than the percentages specified hereinafter.

Prior to the elapsing of 55% of the contract time, the contractor will be disqualified if progress on the contract is more than 40% behind elapsed contract time. After 70% of the contract time has elapsed, the contractor will be disqualified if progress on the contract is more than 25% behind elapsed contract time. Disqualification will be applied between 55% and 70% contract time elapsed on a pro-rata basis; for example, when 60% of the contract time has elapsed, the contractor will be disqualified if progress on the contract is more than 35% behind elapsed contract time.

During the period of disqualification, the contractor will not be permitted to bid on contracts nor be approved as a subcontractor on contracts. The period of disqualification will continue until the completed work on the contract is not delinquent by more than the foregoing percentages or until all work on the contract has been satisfactorily completed. At the contractor's request, progress on the contract will be determined at any time during the period of disqualification.

9-4.2 Disqualification Review Committee: After disqualification, the contractor may submit a written appeal to the Chief Engineer for review by the Department Disqualification Review Committee. The written appeal must be submitted within 10 days after disqualification and may either request (1) a meeting with the Review Committee or (2) that the Review Committee consider a written appeal only. A meeting of the Review Committee will be scheduled within 10 days after receipt of appeal.

The Review Committee will be composed of the Director and 3 other members appointed by the Director.

The decision of the Review Committee will be given to the contractor in writing 10 days after all pertinent information has been considered. The decision of the review board will not operate as a waiver by the City-Parish of its rights to assess liquidated damages as specified under Subsection 9-8.3.

9-5 LIMITATION OF OPERATIONS: The contractor shall conduct the work in such manner as will assure the least interference with traffic and shall have due regard to the location of detours and to provisions for handling traffic. The contractor shall not begin new work to the detriment of work already started, and the engineer may require the contractor to finish a section on which work is in progress before work is started on additional sections if the opening of such section is essential to public convenience.

Work shall be done during daylight hours on week days.

Unless to meet the schedule of completion, or an emergency, special arrangements for which are made, no construction work shall be performed after 10:00 p.m. or on Sundays or holidays, except with permission of the engineer. Before performing work at said times the contractor shall give ample notice to the engineer so that inspection can be provided. No work shall be performed at night unless the contractor has made provisions for proper illumination of the work.

9-6 LABOR AND EQUIPMENT: The contractor shall employ sufficient labor and equipment for prosecuting the work to completion in the specified manner and time. Workmen must have sufficient skill and experience to perform properly the work assigned to them.

Equipment used on the work shall produce a satisfactory quality of work. The engineer may order replacement of unsatisfactory equipment.

Local labor shall be used where available.

9-7 TEMPORARY SUSPENSION OF WORK: The engineer shall have the authority to suspend the work wholly or in part. The order to suspend the work for periods exceeding 1 day shall be in writing and shall include the reasons for suspension. The City-Parish will not be responsible for damages because of delays caused by the contractor.

If the work is suspended by the engineer in the interest of the City-Parish, allowances may be made for the time elapsed during the suspension as hereinafter provided. If the work is suspended by the engineer because of failure or refusal of the contractor to comply with the order of the engineer or with the plans and specifications, or for failure to correct defective workmanship or equipment, the time elapsed during such suspension shall be charged against the contractor.

When the work is suspended, the contractor shall store materials in such manner that they will not obstruct or impede traffic unnecessarily nor become damaged; take precaution to prevent damage or deterioration of the work performed; and provide suitable drainage of the work by opening ditches, shoulder drains, etc., and erect temporary structures where necessary. The work shall be resumed when ordered in writing by the engineer. Liquidated damages shall not accrue during the period in which work is suspended by approval of the engineer unless suspension is due to failure of the contractor to perform a provision of the contract.

9-8 CONTRACT TIME

9-8.1 Determination of Contract Time: The number of days allowed for completion of work in the contract will be stated in the agreement and will be known as the "Contract Time".

The contract time will begin on the beginning date stated in the Notice To Proceed and will continue until the engineer has determined that the major construction items have been completed, the work is usable for its intended purpose and the remaining work can be completed within 30 days; if all work is not completed within 30 days, contract time charges will be resumed.

When the contract time is on a calendar day basis, it shall consist of the number of calendar days stated in the contract counting from the date of beginning stated in the Notice to Proceed, including all Sundays, holidays and non-working days. All calendar days elapsing between the effective dates of any orders of the engineer to suspend work and to resume work for suspensions not the fault of the contractor shall be excluded.

When the contract completion time is a fixed calendar date, it shall be the date on which all work on the project shall be completed.

9-8.2 Extension of Time

9-8.2.1 Extra Work: If extra work is required in accordance with Subsection 4-3 and the contractor requests additional contract time, the Director will recommend to the Council that the contract time be extended by the number of days justified for the extra work.

9-8.2.2 Adverse Weather: Based on NOAA data, the following are the normal number of adverse weather days for the parish. An adverse weather day is one on which rainfall or wet soil conditions will prevent the contractor from performing at least 5 hours of work on the controlling item as shown on the construction progress schedule. The normal number of adverse weather days have been considered in determining the contract time.

Normal Number of Adverse Weather Days Per Calendar Month

Jan 8	April 6	July 7	Oct 5
Feb 6	May 8	Aug 5	Nov 7
Mar 5	June 6	Sept 5	Dec 7

If the contractor believes that the actual number of adverse weather days exceeds the normal number of adverse weather days for any month, the contractor may submit a written request to the engineer for an extension of contract time. Such request shall be accompanied by supporting documentation and shall be received by the engineer by the 15th of the following month. The contractor will be notified in writing within 15 days as to the amount of contract time extension, if any, that is deemed justified by the engineer and will be granted. If the contractor fails to submit such requests in accordance with the foregoing procedure, no contract time extensions based on adverse weather will be considered.

9-8.3 Failure to Complete On Time: For each calendar day that the work remains uncompleted after expiration of the contract time as extended, the sum specified in the agreement will be deducted from payments for the work, not as a penalty but as liquidated damages; if not specified, the sum listed below will be deducted.

Permitting the contractor to continue the work after expiration of the contract time as extended will not operate as a waiver of the City-Parish of its rights under the contract.

<u>Original Contract Amount (Dollars)</u>		<u>Daily Charge (Dollars)</u>
From More Than	To and including	
-----	25,000	150
25,000	50,000	210
50,000	100,000	240
100,000	500,000	270
500,000	1,000,000	330
1,000,000	2,000,000	400
2,000,000	5,000,000	480
5,000,000	10,000,000	600
10,000,000	-----	750

9-9 DEFAULT OF CONTRACT: The amount of liquidated damages will be deducted from payments for the work under the contract or any other contract the contractor has with the City-Parish, and the contractor and his surety shall be liable for liquidated damages in excess of amounts due the contractor under the contract.

The contractor may be placed in default if the contractor:

- (a) Fails to begin the work within 14 days of the beginning date specified in the Notice to Proceed, or
- (b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure completion of said work within the contract time as extended, or
- (c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew rejected work, or
- (d) Discontinues prosecution of the work, or
- (e) Fails to resume work which has been discontinued within 14 days after notice to do so, or
- (f) Becomes insolvent or is declared bankrupt, or commits an act of bankruptcy or insolvency, or
- (g) Allows a final judgment to stand unsatisfied for 14 days, or
- (h) Makes an assignment for the benefit of creditors.

The engineer will give written notice to the contractor and the contractor's surety of such delay, neglect or default.

If the contractor or surety, within 14 days after such notice, shall not proceed in accordance therewith, the Council will, upon written notification from the engineer to the contractor and surety of the fact of such delay, neglect or default and the contractor's failure to comply with

such notice, have authority to take prosecution of the work out of the hands of the contractor. The Council may appropriate or use all materials on the project and may enter into an agreement for the completion of the contract or use such other methods as in the opinion of the engineer will be required for completion of the contract in an acceptable manner. All costs to the City-Parish of completing the work under contract, will be deducted from payments for the work. If such expense exceeds the sum which would have been payable under the contract, the contractor and the surety shall pay to the City-Parish the amount of such excess.

9-10 TERMINATION OF CONTRACT

9-10.1 Fulfillment of Contract: The contract will be considered fulfilled when all work has been completed, the final inspection has been made by the engineer and acceptance has been made by the Council. The contractor will then be released from further obligation except as required by law and the Surety and except as set forth in the surety bond and in Subsections 3-7, 7-8.4 and 10-8.

9-10.2 Termination By City-Parish: If conditions arise that make it impossible or impractical for the City-Parish to proceed with the work, the Council may order termination of the contract.

When a contract, or a portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss of anticipated profits will be considered.

Reimbursement for organization of the work and other overhead expenses (when not otherwise included in the contract), and moving equipment and materials to and from the project will be considered.

Acceptable materials obtained or ordered by the contractor for the work that are not incorporated in the work shall, at the option of the Council, be purchased from the contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as designated.

Termination of a contract or a portion thereof shall not relieve the contractor of responsibilities for the completed work, nor shall it relieve the contractor's surety of its obligation for any just claim arising from the work performed.

SECTION 10

MEASUREMENT AND PAYMENT

10-1 MEASUREMENT OF QUANTITIES: All work completed under the contract will be measured by the engineer according to United States standard measure.

When measurement is specified on a "contract quantity or "design quantity" basis, the City-Parish reserves the right to verify the accuracy of such quantities by field measurements and adjust pay quantities accordingly.

10-1.1 Manufactured Items: When standard manufactured items are specified (such as fence, wire, plates, rolled shapes and pipe) and these items are identified by gage, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

The term "gage" when used in measurement of plates, will mean the U.S. Standard Gage, except that when reference is made to measurement of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term gage will mean that specified in AASHTO M 36 or M 167.

When the term gage refers to measurement of wire, it will mean the wire gage specified in AASHTO M 32.

10-1.2 Structures: Structures will be measured according to neat lines shown on the plans or ordered in writing.

When a complete structure or structural unit is specified as the unit of measurement, the unit will include all necessary fittings and accessories.

10-1.3 Asphalt: Asphalt materials will be measured by the gallon or ton.

When asphalt materials are shipped by truck or transport, net certified weights or volumes subject to correction for loss or foaming may be used for computing quantities.

10-1.4 Portland Cement: Portland cement will be measured by the hundredweight (CWT), being 100 pounds.

10-1.5 Weight: The term "ton" will mean the short ton consisting of 2,000 pounds avoirdupois. Materials measured by weight shall be weighed on approved scales. If material is shipped by rail, the car weight may be accepted provided the weights of material only will be paid for. Trucks used to haul material being paid for by weight shall be weighed empty and each truck shall bear a legible identification mark.

10-1.6 Volume: Materials to be measured by volume in the hauling vehicle will be measured at the point of delivery on the project. Vehicles may be of any size or type provided the body is of such shape that the contents may be readily and accurately determined. Vehicles shall be loaded to at least a predetermined permanently fixed mark that defines a known volume.

When requested by the contractor and approved, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment. Factors for conversion from weight to volume will be determined by the engineer and shall be agreed to by the contractor before such measurement is used.

Upon mutual agreement of the engineer and the contractor, materials specified to be measured by in-place volumes may be measured by truck volumes and converted to in-place volumes, using mutually agreeable conversion factors.

In computing volumes of excavation, the average end area method or other acceptable methods will be used.

10-1.7 Area: For area computation, longitudinal measurements will be made along the surface of the completed item and transverse measurements will be neat dimensions shown on the plans or ordered in writing.

10-1.8 Linear: A station will be 100 linear feet.

Items measured by linear foot, such as pipe culverts, guardrails and underdrains, will be measured parallel to the base or foundation on which such structures are placed.

10-1.9 Lump Sum: The term "lump sum" when used as a method of payment will mean complete payment for the work described in the contract.

10-1.10 Equipment Rental: Rental of equipment will be measured by time in hours of actual working time on the project. "Down time" of rented equipment will be measured if work delays or suspensions are not caused by the contractor.

10-2 SCOPE OF PAYMENT: The contractor shall accept compensation provided for in the contract as full payment for furnishing all materials and performing all work under the contract in an acceptable manner and for all risk, loss, damage or expense arising out of the nature of the work or prosecution thereof.

If the specifications relating to a unit price in the bid schedule requires that said unit price be considered compensation for certain work or material essential to the item, this same work or material will not also be paid for under any other pay item.

Items of work necessary for satisfactory completion of the project, but which are not included in the contract as separate pay items, will be considered subsidiary work and shall be included by the Contractor in the bid prices for pay items appearing in the proposal.

10-3 PAYMENT FOR ALTERED QUANTITIES: When the accepted quantities of work vary from the contract quantities the contractor shall accept as payment in full, payment at the contract unit prices for the accepted quantities of work done. No allowance except as provided in Subsection 4-2 will be made for any increased expense, loss of expected reimbursement or loss of anticipated profits claimed by the contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder or from other cause.

10-4 PAYMENT FOR EXTRA WORK: Authorized extra work performed for which there are no previously established contract prices will be paid for at negotiated unit prices or a negotiated lump sum price. No work shall be started until arrangements have been made with the engineer for inspection.

If requested by engineer, contractor shall provide details of his lump sum or unit price proposal for evaluation, utilizing the costs and allowances given herein for force account work.

If unit prices or a lump sum amount cannot be agreed upon prior to beginning the extra work, the engineer may require the contractor to perform the work on a force account basis utilizing the costs and allowances given in Subsections 10-4. 1 thru 10-4.6; no other costs shall be included.

10-4.1 Labor: For labor and foremen in direct charge of operations, the contractor shall receive the wage rates agreed on in writing before beginning work for each hour that said labor and foremen are engaged in such work.

The contractor shall receive the amounts paid to, or in behalf of, workmen for subsistence or travel allowances, health and welfare benefits, pension fund benefits, or other benefits, when such amounts are required by collective bargaining agreement or other employment contract applicable to the classes of labor employed on the work.

An amount equal to 20% of the sum of the above items will also be paid to the contractor.

10-4.2 Bond, Insurance and Tax: For property damage, liability, workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes, the contractor shall receive the actual cost thereof, to which 6% will be added. The contractor shall furnish satisfactory evidence of the rates paid for such bond, insurance and tax.

10-4.3 Materials: For materials accepted by the engineer and used, the contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid (exclusive of machinery rentals) to which 15% will be added.

10-4.4 Equipment: For machinery or special equipment including fuel and lubricants, plus transportation costs, the use of which has been authorized by the engineer, the contractor shall receive the rental rates agreed upon in writing before such work is begun for the time such equipment is in operation on the work.

10-4.5 Miscellaneous: No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

10-4.6 Subcontracting: When the Department authorizes the work to be subcontracted, the contractor will be paid the cost of such subcontracted work computed as outlined above, plus an additional allowance of 10%.

10-4.7 Compensation: The contractor's representative and the inspector shall compare records of the cost of work done on a force account basis. Such comparison shall be made daily if required by the engineer.

10-4.8 Statements: No payment will be made for work performed on a force account basis until the contractor has furnished the engineer with duplicate itemized statements of the cost of such force account work detailed as follows:

1. Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.
2. Designation, dates, daily hours, total hours, rental rate, and extension of each unit of machinery and equipment.
3. Quantities of materials, prices and extensions.
4. Transportation of materials.
5. Cost of property damage, liability and workmen's compensation insurance premiums, surety bond, unemployment insurance contributions and social security tax.

Statements shall be accompanied by receipted invoices for all materials used and transportation charges. If materials used on the force account work are not specifically purchased for such work but are taken from the contractor's stock, in lieu of invoices the contractor shall furnish an affidavit certifying that such materials were taken from the contractor's stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the contractor; however, such cost shall not exceed the cost of new materials delivered to the project.

10-5 ELIMINATED ITEMS: If any contract items are found unnecessary for proper completion of the work, the engineer may, upon written order to the contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract. When a contractor is notified of the elimination of items, reimbursement will be made for authorized

work done and all costs incurred, including mobilization of materials, prior to said notification. Fabricated or delivered materials which are eliminated and cannot be returned or used shall be hauled to a designated lot of the Department and will be paid for at the invoice price plus transportation.

10-6 PARTIAL PAYMENTS: Provided the work is prosecuted in accordance with the provisions of the contract and with satisfactory progress, the engineer will, on or about the same day of each month as agreed upon between the engineer and the contractor, have prepared an estimate of the value of the work done up to that day.

The monthly estimate will be the value of the approximate amount of work done up to that day, and will be subject to correction on subsequent estimates. The contractor will be paid the amount of the estimate, less the following retainage, within 30 days from the date of receipt of the estimate.

<u>Original Contract Amount</u>	<u>Percent Retained</u>
Up to \$500,000	10
\$500,000 or More	5

If defective work or material is discovered, or doubt arises as to the integrity of any part of the work completed previous to final acceptance and payment, there will be deducted from the first estimate rendered after discovery of such defective or questioned work an amount equal in value to the defective or questioned work, and this work will not be included in a subsequent estimate until defects have been remedied or doubt removed.

Payment of the monthly estimate shall not be an admission that the work is done or its quality is satisfactory, nor a release of the contractor from responsibility for any portion thereof.

10-7 PAYMENT FOR STOCKPILED OR STORED MATERIAL: Upon written request, the invoice cost, less the retainage specified in Subsection 10-6, of approved materials stored or stockpiled at the project site or other designated location in the vicinity of such construction will be paid. Payment will not exceed the total estimated quantity required to complete the project. The agreed value will not exceed the appropriate portion of the contract item or items in which such materials are to be incorporated. Payment will be limited to durable materials that represent a significant portion of the project cost, such as aggregates, bridge timber, structural steel and reinforcing steel. Perishable articles and small warehouse items will not be included.

Payment for stockpiled or stored materials will not constitute acceptance. It shall be the contractor's responsibility to protect the material from damage while in storage.

The contractor shall furnish the engineer a certified inventory of the quantity of each stockpiled item and its invoiced cost when advance payment is requested.

Within 30 days after payment by the City-Parish the contractor shall submit a copy of a certified paid invoice statement to the engineer for each item for which payment has been made.

If certification of payment is not presented within the 30-day period, the advanced payment will be deducted from the next progress payment.

Ownership of materials for which advancements have been made by the City-Parish shall not vest in the City-Parish until such materials are incorporated in the work and the City-Parish shall not release the contractor from responsibility for any portion thereof. The contractor shall save the City-Parish harmless in the event of loss or damage of materials for which advancements have been made. The amounts advanced on stockpiled or stored materials will be deducted from payments of monthly estimates as the materials are incorporated into the work.

10-8 ACCEPTANCE AND FINAL PAYMENT: When in the opinion of the engineer, the contractor has completed the work in an acceptable manner and in accordance with the terms of the contract, the engineer will make a final inspection of the entire work and upon completion of final surveys and computations of final quantities prepare a final estimate indicating the amount of money to be paid to the contractor, except such sums that can be lawfully retained under the provisions of the contract. The engineer will certify the final estimate and recommend acceptance of the contract by the Council.

When the Council has accepted the work, the contractor will be issued a notice of acceptance for filing with the Recorder of Mortgages for East Baton Rouge Parish.

Retainage will be paid to the contractor upon receipt by the Finance Department of a clear lien certificate issued to the contractor by the Recorder of Mortgages after expiration of the 45-day lien period.

Payment of the final estimate shall not release the contractor or the contractor's surety from liability for any fraud in construction or in obtaining progress payments, or in payment for materials, labor or other supplies or services incidental to the work, or for claims of damages, loss or injury sustained by any person through the fault, negligence or conduct of the contractor or the contractor's employees.

PART II
EARTHWORK

SECTION	TITLE	PAGE
201	Clearing and Grubbing	50
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SECTION 201

CLEARING AND GRUBBING

201-1 DESCRIPTION: This work consists of clearing, grubbing, removing and disposing of vegetation and debris within rights-of-way, servitudes and easement areas, or as shown on the plans, except items that are designated to remain or to be removed under other items.

201-2 GENERAL REQUIREMENTS: The engineer will designate trees, shrubs, plants and other items to remain, and the contractor shall preserve such items. Equipment, materials and supplies shall not be stored in proximity of items designated to remain. In case of damage to bark, trunks, limbs or roots of vegetation designated to remain, the contractor shall repair such damage by AAN horticultural and tree surgery practices. Trees shall not be felled outside rights-of-way, servitudes or easement areas. Damage outside rights-of-way, servitudes or easement areas caused by the contractor's operations shall be the contractor's responsibility.

Trees, stumps, roots and other protruding vegetative obstructions not designated to remain shall be cleared and grubbed (including mowing when required).

Roots and nonperishable solid objects which will be at least 3 feet below subgrade or embankment slope will be permitted to remain if they do not extend more than 6" above original ground line or low water level.

When fencing or utility relocation is required, an area 10 feet wide, adjacent to and inside right-of-way line, shall be cleared and grubbed.

Timber to be cleared which has not been removed prior to beginning the work shall become the property of the contractor.

Low hanging, unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches extending over roadbed shall be trimmed at least 20 feet above pavement.

Trimming shall be done in accordance with AAN horticultural and tree surgery practices.

Removed materials shall be disposed of in accordance with Subsection 202-2.

Except in areas to be excavated, holes left from clearing and grubbing shall be backfilled and compacted to at least the density of surrounding soils.

201-3 CHANNEL CLEARING: Channel clearing consists of cutting, mowing, stacking, treating and clearing of all weeds, brush, trees and debris from within the channel and berms of open drainage channels.

The contractor shall notify the engineer at least 2 weeks prior to beginning work so that areas and trees or plants not to be cleared can be marked.

Unless otherwise directed, structures located within clearing limits may be temporarily removed for execution of the work. Upon completion of the work, items removed shall be reinstalled or relocated to a condition equal to the condition that existed before the structure was removed. The contractor shall be liable for damage due to his operations to structures in the clearing area or on adjacent property.

On private property (rights-of-entry), timber designated by the property owner to remain shall be cut and placed on the property outside the limits of the channel.

Within the channel, weeds, brush, and trees shall be cut flush with the ground surface, except that trees along steep slopes at the waters edge may be cut to a height of approximately 3 feet and tapered in decreasing height to flush with ground level as you move up the slope.

All felled material shall be promptly removed from the channel. Felled material suitable for chipping may be chipped and spread on the cleared areas; material not chipped shall be disposed of beyond the project in accordance with Subsection 202-2.

Tree stumps shall be chemically treated to provide at least 90% kill of regrowth. Immediately after cutting, tree stumps shall be split and treated with Tordon 101R or RTU in accordance with the manufacturer's instructions at the rate of 1.0 ml of undiluted material per 3" of stump diameter, after which a red vegetable or agricultural dye shall be applied. The contractor shall comply with State and Federal regulations governing labeling and use of herbicides.

201-4 MEASUREMENT: If a pay item for clearing and grubbing, removal of trees, channel clearing, or hauling and disposal is included in the contract, measurement will be made as follows:

(a) **Clearing and Grubbing:** Clearing and grubbing will be measured per acre or on a lump sum basis, as specified. The quantity for acre measurement will be the contract quantity, adjusted as required due to plan errors or plan changes.

201-5

(b) **Removal of Trees:** Removal of trees will be measured per each tree of specified size removed.

(c) **Channel Clearing:** Channel clearing will be measured on a lump sum basis.

(d) **Hauling and Disposal:** Hauling and disposal will be measured on a lump sum basis.

201-5 PAYMENT: If no pay item for clearing and grubbing, removal of trees, channel clearing, or hauling and disposal is included in the contract, no direct payment will be made for this work.

If a pay item for clearing and grubbing, removal of trees, channel clearing, or hauling and disposal is included in the contract, payment will be made as follows:

(a) **Clearing and Grubbing:** Payment will be made at the contract unit price per acre or the contract lump sum price, as specified, which includes all required clearing and grubbing on the project.

(b) **Removal of Trees:** Payment for removal of trees will be made at the contract unit price per each.

(c) **Channel Clearing:** Payment will be made at the contract lump sum price.

(d) **Hauling and Disposal:** Payment will be made at the contract lump sum price.

201-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
2010100	Clearing and Grubbing	Lump Sum
2010200	Clearing and Grubbing	Acre
201030-	Removal of Trees (Size)	Each
2010401	Light Channel Clearing	Lump Sum
2010402	Dense channel Clearing	Lump Sum
2010500	Hauling and Disposal	Lump Sum

SECTION 202**REMOVAL OF STRUCTURES AND OBSTRUCTIONS**

202-1 DESCRIPTION: This work consists of removal and disposal of buildings, floor slabs, foundations, septic tanks, culverts, fences, structures, soil cement base courses, pavements, walks, drives, abandoned pipe lines, and other obstructions which are not designated or permitted to remain, except obstructions to be removed under other items. It shall also include salvaging designated materials and backfilling resulting trenches and holes.

202-2 CONSTRUCTION: The contractor shall remove and dispose of all buildings and foundations, structures, fences and other obstructions on the right of way, except utilities and those for which other provisions have been made for removal. Designated salvageable material shall remain the property of the City-Parish and shall be removed, without unnecessary damage, in sections which may be readily transported and shall be hauled to a designated maintenance storage yard and stacked. Dismantling of bridges shall include removal of hardware and nails. Steel members shall be match marked before dismantling. Materials not to be salvaged shall be disposed of off the project. Cavities left by structure removal shall be filled to the level of the surrounding ground and compacted to at least the density of surrounding ground.

Substructures of bridges shall be removed to natural stream bottom and parts outside the stream shall be removed to 1 foot below natural ground surface. Existing structures within the limits of a new structure shall be removed as necessary to accommodate construction of the new structure.

Blasting or other operations necessary for removal of a structure or obstruction which may damage new construction shall be completed prior to placing the new work.

When saw cutting of pavements, walks, etc. is specified, depth of saw cut shall be at least 1/3 the depth of pavement, walk, etc.

202-3 MEASUREMENT: When the contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item will include all structures and obstructions encountered on the project. When the contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the contract.

Saw cutting will be measured by the linear foot.

202-4 PAYMENT: When the contract includes the pay item, "Removal of Structures and Obstructions", payment will be made at the contract lump sum price.

When the contract includes pay items for the removal of specific structures or obstructions, payment will be made at the contract unit price.

202-5

Payment includes removal, disposal, salvage (when specified), and excavation and backfill incidental to the removal. Payment for removal of concrete pavement includes any asphalt overlay.

Payment for saw cutting will be made at the contract unit price per linear foot.

When the contract does not include pay items for removal of structures and obstructions, no direct payment will be made for the removal work.

202-5 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
2020100	Removal of Structures and Obstructions	Lump Sum
2020200	Removal of Bridges	Each
2020300	Removal of Concrete Pavement	Square Yard
2020400	Removal of Asphalt Surfacing	Square Yard
2020500	Removal of Asphalt Surfacing and Base	Square Yard
2020600	Removal of Concrete Walks and Drives	Square Yard
2020700	Removal of Concrete Curb	Linear Foot
2020800	Removal of Concrete Curb and Gutter	Linear Foot
2020900	Saw Cutting Concrete or Asphalt	Linear Foot

SECTION 203

EXCAVATION AND EMBANKMENT

203-1 DESCRIPTION: This work consists of excavation, disposal, placement and compaction of soil materials for roadways and other structures, excavation for ditches and channels, and other grading operations necessary for the work. This work also includes the removal and disposal of existing drainage pipe and boxes, unless separate pay items are provided for such removal.

203-2 GENERAL EXCAVATION: General excavation consists of excavation of materials within the right-of-way, servitudes or easements, except muck excavation, channel excavation or structural excavation.

203-3 CHANNEL EXCAVATION: Channel excavation consists of excavation for drainage beyond the limits of the roadway section (except for wing ditches at cuts), inlet and outlet ditches to structures or roadways, changes in or deepening of stream channels, berm ditches, ditches parallel or adjacent to the roadway beyond the limits of the roadway section, and material excavated under bridges.

203-4 STRUCTURAL EXCAVATION: Structural excavation consists of excavation for construction of retaining walls, bridge foundations and other structures.

203-5 MUCK EXCAVATION: Muck excavation consists of removing materials which will decay or produce subsidence in the embankment, or materials containing stumps, roots, logs, humus, or other material not satisfactory for use in the embankment. The engineer will determine the material to be removed. Removed material which cannot be used shall be disposed of in accordance with Subsection 202-2.

203-6 BORROW MATERIAL: Borrow material consists of soils required for construction of embankments or other portions of the work in excess of soils obtained from excavation. Borrow material for embankments shall have a maximum PI of 25 (DOTD TR 428), a maximum organic content of 5% (DOTD TR 413), and a maximum silt content of 60% (DOTD TR 407).

Borrow material for use in base or subbase courses shall conform to Subsection 304-2(a).

The contractor shall notify the engineer at least 10 days in advance of borrow operations so that samples may be taken and soil tests completed prior to beginning borrow operations. The contractor will not be permitted to begin borrow operations until materials are approved for use.

203-7 CONSTRUCTION:

(a) **General Requirements:** Embankment material shall be placed in uniform layers not exceeding 12" uncompacted thickness. Each layer **203-7**

shall be placed for the full width of embankment and compacted to at least 95% of maximum density determined by AASHTO T 99. Operations shall be so conducted as to prevent lamination between lifts.

Surfaces of excavated areas and embankments shall be smooth and uniform. Material outside construction limits shall not be disturbed. Surplus excavated material shall be disposed of in accordance with Subsection 202-2.

When obliteration of old roadways is required, it shall include grading operations necessary to incorporate the old roadway into the new roadway and surroundings to provide a pleasing appearance.

Unstable materials shall be removed by undercutting and backfilled to required section with stable soils. When undercutting is required, the contractor shall so conduct the operations that the engineer can make pay measurements before backfill is placed.

The contractor will be responsible for stability of embankments until final acceptance. Construction activities which cause embankment damage will not be permitted.

When embankments are constructed on a surface sloping more than 6:1 from the horizontal, the ground on which embankment is to be placed shall be cut into steps as directed before fill is placed.

If fill height is 3 feet or more, the area shall be disked and satisfactorily recompacted before fill is placed. If fill height is less than 3 feet, the area shall be scarified for at least a 9" depth and recompacted to at least 95% of maximum density determined by AASHTO T 99 before fill is placed.

No embankment or backfill material shall be placed against a concrete retaining wall or cast-in-place box culvert until the concrete has been in place for at least 14 days or until the concrete has attained at least 3,000 psi compressive strength. When embankment is placed on both sides of a concrete wall or similar structure, operations shall be conducted so that the embankment is always at approximately the same elevation on both sides of the structure.

When embankments are constructed in lakes, streams, swamps or other unstable areas and unstable material cannot be removed or the area drained, embankment shall be placed by end dump or other approved methods to an elevation where normal construction methods can begin. Embankments placed above this elevation shall be constructed in layers as specified above.

If the contractor encounters cultural artifacts or archaeological or historical sites, operations shall be discontinued. The engineer will contact the proper authorities to determine the disposition thereof and necessary actions relative to the site. When directed, the contractor shall excavate the site to preserve the artifacts. Such excavation will be paid for as extra work, including an appropriate adjustment in contract time.

(b) **Cut Area Preparation:** When a base course, subbase or embankment is to be constructed on the surface of a cut section, the area shall be scarified to a depth of 9" and recompacted to at least 95% of maximum density determined in accordance with AASHTO T 99.

(c) **Geotextile Fabric Placement:** Geotextile fabric shall conform to Subsection 1022-8 and shall be protected from sunlight until use. Fabric shall be covered within 7 days after placement. Adjacent rolls of fabric shall be overlapped at least 2 feet at sides and ends. Fabric shall be satisfactorily secured with pins or staples.

(d) **Channels:**

(1) **Excavation:** If slides occur during the work, slide material shall be removed from the channel bottom, and slopes restored to required section.

Inlets of side ditches and tributaries shall be graded to a minimum bottom width of 2 feet and side slopes not steeper than 2:1.

Where bridges are of ample size, the channel shall be excavated to required section beneath the bridge. If bridges are not of ample size to accommodate the required section, the channel shall be excavated as directed under the bridge.

Where the channel goes through culverts, the culverts shall be cleaned of dirt and debris.

(2) **Backfill:** Material from channel excavation that is reasonably free of vegetation and debris may be used for channel backfill. Backfill shall be placed in layers not exceeding 12" uncompacted thickness and each layer compacted to at least 90% of maximum density determined by AASHTO T 99.

203-8 MEASUREMENT:

(a) **Excavation:** Quantities of excavation for payment will be the contract quantities, adjusted as required due to plan errors or plan changes. Payment includes disposal of surplus removed materials.

Temporary excavations to facilitate construction operations will not be measured.

(b) **Borrow Material:**

(1) **In-Place:** Borrow material in-place on the work will be measured as specified for excavation in Heading (a) above. However, by mutual agreement between the contractor and the engineer, borrow material may be measured in hauling vehicles at the jobsite and divided by 1.3 to determine the in-place quantity.

(2) **Truck Measure:** The material will be measured by the cubic yard in hauling vehicles on the jobsite.

203-9

(c) **Ditch Grading:** Ditch grading will be measured by the station along the ditch centerline.

(d) **Excavation and Embankment:** When payment for excavation and embankment is specified to be made on a lump sum basis, this item includes performing all excavation, embankment and grading work necessary for construction of the project. It is the contractor's responsibility to determine the correct quantities of earthwork required to complete this item. No adjustment in contract price will be made due to errors in any estimated earthwork quantities shown on the plans. Payment for any required borrow material will be included in the contract price for this item.

(e) **Geotextile Fabric:** The quantity of geotextile fabric for payment will be the contract quantity, adjusted as required due to plan errors or plan changes.

(f) **Channel Backfill:** The quantity of channel backfill for payment will be the contract quantity, adjusted as required due to plan errors or plan changes.

203-9 PAYMENT: Payment will be made at the contract unit prices.

Payment for undercut and roadway obliteration will be made as "General Excavation".

203-10 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
2030100	General Excavation	Cubic Yard
2030200	Borrow Material (In-Place)	Cubic Yard
2030300	Borrow Material (Truck Measure)	Cubic Yard
2030400	Channel Excavation	Cubic Yard
2030500	Structural Excavation	Cubic Yard
2030600	Muck Excavation	Cubic Yard
2030700	Ditch Grading	Station
2030800	Excavation and Embankment	Lump Sum
2030900	Geotextile Fabric	Square Yard
2031000	Channel Backfill	Cubic Yard

PART III

BASE AND SUBBASE COURSES

SECTION	TITLE	PAGE
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302	Aggregate Base Course	60
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305	Portland Cement Concrete Base Course	67

SECTION 301

SCARIFYING AND COMPACTING ROADBED

301-1 DESCRIPTION: Scarifying and compacting roadbed consists of scarifying, shaping and compacting an existing roadbed to form a subbase or base course. This work also includes improving sections of the roadside ditches when designated on the plans.

301-2 CONSTRUCTION: Existing materials shall be scarified for the full width of roadbed and a minimum depth of 6", shaped to the required section, and compacted to at least 95% of maximum density determined by AASHTO T 99. The scarified, shaped and compacted roadbed shall have a closely knit surface, free from ridges, waves, depressions or loose material. Scarifying shall not be performed in excess of 1/2 mile in advance of compacting the roadbed. The recompacted roadbed shall be primed in accordance with Subsection 302-3.

Ditches shall be excavated and cleaned to the new grades shown on the plans. Suitable material removed from ditches may be used in the roadbed.

Excavated materials not suitable for use in the roadbed shall be disposed of off the project.

301-3 MEASUREMENT: Quantities of scarifying and compacting roadbed for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

301-4 PAYMENT: Payment for scarifying and compacting roadbed will be made at the contract unit price per station, which includes prime coat.

301-5 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
3010100	Scarifying and Compacting Roadbed	Station

SECTION 302

AGGREGATE BASE COURSE

302-1 DESCRIPTION: This work consists of furnishing and placing a base course of stone or sand-clay-gravel on a prepared subgrade.

302-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Sand Clay Gravel	1001-3.1
Stone	1001-3.2
Asphalt Prime Coat	1003

302-3 CONSTRUCTION: Base course material shall be transported and spread by methods that do not damage the subgrade. Any damaged subgrade shall be repaired before base course is placed thereon.

Base material shall be shaped and compacted to at least the following percentage of maximum density determined by AASHTO T 99.

Sand Clay Gravel	100%
Stone	95%

Upon completion of compaction operations, the base shall be prime coated with grade MC 30 or MC 70 cutback asphalt, or grade AEP emulsified asphalt, at the minimum rate of 0.25 gallon per square yard. Prime coat shall be allowed to cure for at least 24 hours prior to placement of surfacing.

302-4 MEASUREMENT:

(a) **In-Place:** The quantities of aggregate base course for payment will be the contract quantities, adjusted as required due to plan errors or plan changes. Contract quantities are based on horizontal dimensions and compacted thickness of base course shown on the plans.

(b) **Truck Measure:** Aggregate base course will be measured by the cubic yard, truck measure, at the jobsite. Materials delivered by weight will be measured by the ton in trucks and divided by 1.5 to determine the pay quantity.

302-5 PAYMENT: Payment for aggregate base course will be made at the contract unit price per cubic yard, which includes furnishing and placing the aggregate and asphalt prime coat.

302-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
3020100	Sand-Clay-Gravel Base Course (In-Place)	Cubic Yard
3020200	Sand-Clay-Gravel Base Course (Truck Measure)	Cubic Yard
3020300	Stone Base Course (In-Place)	Cubic Yard
3020400	Stone Base Course (Truck Measure)	Cubic Yard
30205--	Stone Base Course (___" Thick)	Square Yard

SECTION 303

SUBGRADE TREATMENT

303-1 DESCRIPTION: This work consists treating subgrade materials in accordance with plan details and these specifications.

The contractor has the option of treating subgrade materials with hydrated lime, blended lime or portland cement.

303-2 MATERIALS: Materials shall conform to the following Subsections:

Portland Cement	1002-1
Hydrated Lime	1002-3.1
Blended Lime	1002-3.2
Water	1002-4

303-3 CONSTRUCTION:

(a) **Proportioning:** Hydrated lime, blended lime or portland cement shall be added to subgrade materials at the following rates:

	% by Volume (Dry)		
	<u>Type A</u>	<u>Type B</u>	<u>Type C</u>
Hydrated Lime	12	10	8
Blended Lime	18	15	12
Portland Cement	7	6	5

(b) **Mixing:**

(1) **Lime:** The following unit weights shall be used to determine the required application rates of lime:

	<u>lb/CuFt</u>
Hydrated Lime	35
Blended Lime	40

Hydrated lime may be placed in either dry form or as a slurry, and shall be thoroughly mixed with materials to be treated. The contractor shall process hydrated lime in such manner that lime dust will not be hazardous to workmen or the public.

Initial mixing shall be performed the same day lime is placed. After initial mixing, the section treated shall be shaped, lightly compacted and left undisturbed for at least 48 hours, after which the soil-lime mixture shall be scarified, pulverized and reshaped.

(2) **Portland Cement:** Portland cement shall be mixed with subgrade materials in accordance with Subsection 304-3.

(c) **Compaction:** Treated subgrade materials shall be compacted to at least 95% of maximum density determined by AASHTO T 99.

Cement treated subgrade materials shall be cured in accordance with Subsection 304-3 for at least 72 hours.

303-4 MEASUREMENT: The quantity of subgrade treatment for payment will be the contract quantity, adjusted as required due to plan errors or plan changes.

303-5 PAYMENT: Payment for subgrade treatment will be made at the contract price per square yard, which includes furnishing all required cement or lime and mixing it with subgrade materials, and compacting and curing the subgrade.

303-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
30301--	Type A Subgrade Treatment (___" Thick)	Square Yard
30302--	Type B Subgrade Treatment (___" Thick)	Square Yard
30303--	Type C Subgrade Treatment (___" Thick)	Square Yard

SECTION 304

SOIL CEMENT BASE COURSE

304-1 DESCRIPTION: This work consists of constructing a base course composed of portland cement and soil. Soil for the base course shall be in-place materials that are suitable for cement stabilization or materials that are furnished under other items.

Concrete conforming to Section 1005 may be used in lieu of soil cement base course in areas inaccessible to mixing and compacting equipment, in turnouts and crossovers, and in other isolated or irregular areas. Concrete shall be Class 5B3000, and shall be placed, consolidated, finished and cured as directed.

304-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Portland Cement	1002-1
Water	1002-4
Emulsified Asphalt	1003

(a) **Soils:** Soils shall consist of materials that will stabilize with cement in accordance with DOTD TR 432. Soil with a Liquid Limit greater than 35 (AASHTO T 89), a PI greater than 15 (AASHTO T 90), organic content greater than 2% (DOTD TR 413), sand content over 80% (DOTD TR 407), or silt content over 70% (DOTD TR 407) shall not be used.

(b) **Portland Cement:** Portland cement shall be Type I, I(B) or II.

304-3 CONSTRUCTION

(a) **Roadbed Preparation:** The contractor shall scarify and pulverize materials to be stabilized for the full width and depth of base course. Any existing asphalt surfacing shall be pulverized and uniformly mixed with materials below the surfacing. Materials which cannot be satisfactorily pulverized shall be removed.

After the roadbed has been prepared, the roadbed shall be shaped to the required section and lightly compacted.

Scarifying and pulverizing operations shall not be conducted more than 1/2 mile in advance of base course stabilization, unless otherwise permitted.

(b) **Mixing:** The required percentage of cement will be determined by DOTD TR 432 prior to mixing. When central plant mixing is used, a 1% reduction in cement content will be permitted.

Soil shall be combined with cement and water by in-place mixing or in an approved central plant. At least 70% of the pulverized soil (exclusive of rock and gravel) shall pass the No. 4 sieve after mixing.

On open ditch sections, a stringline shall be placed along each side of the base course before spreading cement. Cement shall be uniformly spread over the base course. Cement falling outside the base course shall be swept back onto the base before mixing.

(c) **Compaction and Finishing:** Immediately upon completion of mixing, the material shall be compacted to at least 95% of maximum density determined by AASHTO T 99. The surface shall be kept moist during compacting and finishing.

At places inaccessible to rollers, such as edges adjacent to curb and gutter sections, the mixture shall be compacted using devices that will obtain specified density without damage to adjacent structures.

Compaction operations shall be completed within 3 hours after placement of cement. After the 3-hour period, only tight blading of the base course surface shall be performed. Bladed materials shall not be drifted along the base, but shall be removed.

The contractor shall complete finishing operations and apply asphalt curing membrane within 24 hours after initial mixing of cement. The finished base course shall have a closely knit surface free from laminations or loose material.

Upon completion of final finishing, the base shall be protected against rapid drying for at least 7 days by applying an emulsified asphalt curing membrane at the minimum rate of 0.10 gallon per square yard. When diluted with water, the rate of application shall be increased accordingly.

Base course defects shall be corrected by removing and replacing the full depth of base course in defective areas with one of the following materials, placed as directed:

1. Soil cement base course
2. Asphalt concrete conforming to Section 1004
3. Portland cement concrete (Class 5B3000) conforming to Section 1005

304-4 ACCEPTANCE REQUIREMENTS:

(a) **General:** Sampling and testing for acceptance will be performed on each lot of soil cement base course for width and thickness. A soil cement base course lot is 4,000 square yards. The final area of base course constructed will be considered as a lot if it is at least 2,000 square yards; otherwise, it will be included in the previous lot.

(b) **Width:** In curbed sections, the width of completed base course shall be plan width. In open ditch sections, the width of completed base course shall not vary from plan width on each side more than 3" underwidth nor 6" overwidth.

304-5

(c) **Thickness:** Thickness of completed base courses will be determined from cores taken after the 7-day curing period. Each lot will be divided into 5 equal segments and 1 core will be obtained from each segment. Core holes shall be patched by the contractor with an approved concrete mix.

The average thickness of the base course lot shall not vary from plan thickness more than 3/4" underthickness nor 1 1/4" overthickness. In calculating average base course thickness, cores of more than 1 1/4" overthickness will be considered as 1 1/4" overthickness.

304-5 MEASUREMENT:

(a) **Processing Soil Cement:** The pay quantity of soil cement processing will be the contract quantity, adjusted as required due to plan errors or plan changes.

(b) **Portland Cement:** Portland cement will be measured by the hundredweight (CWT) determined from the theoretical volumetric percentage of cement required for stabilization.

304-6 PAYMENT:

(a) **Processing Soil Cement:** Payment for soil cement processing will be made at the contract unit price per square yard, which includes pulverizing roadbed materials, mixing cement into the roadbed, furnishing and applying required water, compacting and finishing the soil cement, and furnishing and applying asphalt curing membrane.

(b) **Portland Cement:** Payment for portland cement will be made at the contract unit price per hundredweight (CWT), which includes furnishing, placing and spreading the cement.

304-7 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
30401--	___" Soil Cement Processing	Square Yard
3040200	Portland Cement	CWT

SECTION 305

PORTLAND CEMENT CONCRETE BASE COURSE

305-1 DESCRIPTION: This work consists of furnishing and constructing portland cement concrete base course.

305-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Portland Cement Concrete (Class 5B3000)	1005
Joint Materials	1007
Dowel Bars	1006-4
Curing Materials	1008-1

305-3 CONSTRUCTION: Concrete base course shall be constructed in accordance with Section 502, except as follows.

Dowel bars will not be required in contraction joints, and expansion joint edges need not be tooled. In split slab construction a continuous keyway shall be provided along the longitudinal joint; tie bars will not be required. A keyway shall also be provided at transverse construction joints; however, dowel bars will not be required. Floating and final finishing of the concrete surface will not be required.

305-4 ACCEPTANCE REQUIREMENTS: Acceptance requirements for concrete base course shall be the same as specified for concrete pavement in Subsection 502.11, except that surface tolerance requirements will not be applied.

305-5 MEASUREMENT: The pay quantity of concrete base course will be the contract quantity, adjusted as required due to plan errors or plan changes.

305-6 PAYMENT: Payment for concrete base course will be made at the contract unit price per square yard, which includes furnishing and placing concrete, dowel bars, joint materials and curing compound.

305-7 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
30501--	___" Portland Cement Concrete Base	Square Yard

PART IV

SURFACE COURSES

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SECTION 401

TRAFFIC MAINTENANCE AGGREGATE

401-1 DESCRIPTION: This work consists of furnishing and placing aggregate surfacing for traffic maintenance.

401-2 MATERIALS: Aggregate shall be stone, crushed concrete or gravel and shall be satisfactory to the engineer.

401-3 CONSTRUCTION REQUIREMENTS: The contractor shall place, shape, compact and maintain the aggregate as necessary for traffic maintenance. When directed, the aggregate material shall be reused on the project for traffic maintenance at no direct pay. When aggregate surfacing is no longer necessary for traffic maintenance, the contractor shall remove and dispose of the aggregate surfacing.

401-4 MEASUREMENT: Traffic maintenance aggregate will be measured by the cubic yard, truck measure, at the jobsite. Materials delivered by weight will be measured by the ton and divided by the following factor to convert to loose volume.

	Factor
Stone or Crushed Concrete	1.5
Gravel	1.2

401-5 PAYMENT: Payment for traffic maintenance aggregate will be made at the contract unit price per cubic yard.

401-6 PAY ITEM:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
4010100	Traffic Maintenance Aggregate, Truck Measure	Cubic Yard

402-1

SECTION 402

AGGREGATE SURFACE COURSES

402-1 DESCRIPTION: This work consists of furnishing and constructing aggregate surfacing.

402-2 MATERIALS: Materials shall conform to the following Subsections:

Stone or Crushed Concrete	1001-4.1
Gravel	1001-4.2

402-3 CONSTRUCTION REQUIREMENTS: The contractor shall place surfacing by methods that do not damage the subgrade. Damaged subgrade shall be repaired prior to placement of surfacing.

Surfacing shall be shaped to the required section and compacted by at least 3 passes of a pneumatic-tire roller.

402-4 MEASUREMENT:

(a) **Truck Measurement:** Aggregate surfacing will be measured by the cubic yard, truck measure, at the jobsite. Materials delivered by weight will be measured by the ton and divided by the following factor to determine the pay quantity:

Stone or Crushed Concrete	1.5
Gravel	1.2

(b) **In-Place:** The quantities of aggregate surface course for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

402-5 PAYMENT: Payment for aggregate surfacing will be made at the contract unit price.

402-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
4020100	Aggregate Surface Course, Truck Measure	Cubic Yard
4020200	Aggregate Surface Course, In-Place	Cubic Yard
402030-	Aggregate Surface Course (_ " Thick)	Square Yard

SECTION 403

ASPHALT SURFACE TREATMENT

403-1 DESCRIPTION: This work consists of furnishing and constructing a wearing surface of asphalt and aggregates.

403-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Asphalt	1003
Aggregates	1001-5

Emulsified asphalt (CRS-2) shall be used in Type A treatments, and polymerized emulsified asphalt (CRS-2P) shall be used in Type B treatments.

403-3 CONSTRUCTION:

(a) **Weather Limitations:** Asphalt shall not be applied on a wet surface nor when air temperature is below 60° F.

(b) **Surface Preparation:** Before applying asphalt, the surface shall be cleaned of dirt and loose material.

(c) **Asphalt/Aggregate Application:** Sequence of application, spread rates and asphalt application temperature shall be as given in Table 4-1.

TABLE 4-1
ASPHALT SURFACE TREATMENT
ASPHALT/AGGREGATES PER SQUARE YARD

	GAL OF ASPHALT		CUBIC YARDS OF AGGREGATE		
	TYPE A	TYPE B CRS-2L OR CRS-2P	SIZE 1	SIZE 2	SIZE 3
<u>3-Course Treatment</u>					
1st Course	0.52	0.47	0.0200		
2nd Course	0.42	0.36		0.0111	
3rd Course	0.31	0.26			0.0075
<u>2-Course Treatment</u>					
1st Course	0.47	0.40	0.0111		
2nd Course	0.31	0.29		0.0075	
<u>Asphalt Application Temperature</u>			Minimum	Maximum	
CRS-2			125° F	175° F	
CRS-2P			160° F	175° F	

(1) **Asphalt:** The length of asphalt spread shall not exceed that which can be covered immediately with aggregate.

403-4

Asphalt shall be applied uniformly with a power distributor for the full width of treatment, unless otherwise directed. If applied over less than the full width, adjacent applications shall be slightly overlapped. The distributor shall be operated along a stringline or other marked edge.

Heavy duty paper or other suitable material shall be used at transverse junctions of asphalt spreads to prevent excess asphalt application.

Hand-held sprayers shall be used to cover areas not accessible to the distributor.

(2) **Aggregates:** Aggregate shall be spread immediately after asphalt is applied. Equipment shall not be allowed on uncovered asphalt. Aggregates shall be spread by dump trucks equipped with spreader boxes or by pneumatic-tire power spreaders. Hand spreading shall be used in areas inaccessible to spreading equipment.

The surface shall be rolled immediately after aggregate spreading with a power roller in a longitudinal direction beginning at outer edges, each pass overlapping the previous pass by 1/2 the roller width. Rolling shall be completed within 1/2 hour after aggregate placement.

(d) **Multiple Applications:** Each application shall be allowed to cure for at least 24 hours before additional applications.

After rolling of cover coat material, the surface shall be maintained for 4 days. Maintenance shall include distribution of cover coat material over the surface to absorb any free asphalt and cover any area deficient in cover coat material. The maintenance shall be conducted so as not to displace imbedded material. Excess material shall be swept from the surface upon completion of the 4-day maintenance period.

403-4 MEASUREMENT: The quantities of asphalt surface treatment for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

403-5 PAYMENT: Payment for asphalt surface treatment will be made at the contract unit price per square yard.

403-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
4030100	3-Course Type A Asphalt Surface Treatment	Square Yard
4030200	2-Course Type A Asphalt Surface Treatment	Square Yard
4030300	3-Course Type B Asphalt Surface Treatment	Square Yard
4030400	2-Course Type B Asphalt Surface Treatment	Square Yard

SECTION 404

ASPHALT CHIP SEAL

404-1 DESCRIPTION: This work consists of furnishing and placing an asphalt/aggregate seal coat on an existing asphalt surfaced pavement.

404-2 MATERIALS: Materials shall conform to the following Sections and Subsections.

Asphalt	1003
Aggregates	1001-6

Emulsified asphalt (CRS-2) shall be used in Type A seals, and polymer-modified (CRS-2P) emulsified asphalt shall be used in Type B seals.

404-3 CONSTRUCTION:

(a) **Weather Limitations:** Asphalt shall not be applied on a wet surface or when air temperature is below 60° F.

(b) **Surface Preparation:** Any raised pavement markers shall be removed and the surface cleaned of dirt and loose material.

(c) **Asphalt/Aggregate Application:** Spread rates and asphalt application temperature shall be as given in Table 4-2.

**TABLE 4-2
ASPHALT CHIP SEAL
ASPHALT/AGGREGATES PER SQUARE YARD**

	GAL OF ASPHALT	CUBIC YARDS OF AGGREGATE
Type A Seal	0.42	0.0111
Type B Seal	0.37	0.0111
<u>Asphalt Application Temperature</u>	Minimum	Maximum
Type A (CRS-2)	125° F	175° F
Type B (CRS-2P)	160° F	175° F

(1) **Asphalt:** The length of asphalt spread shall not exceed that which can be covered immediately with aggregate.

Asphalt shall be applied uniformly with a power distributor for the full width of treatment, unless otherwise directed. If applied over less than the full width, adjacent applications shall be slightly overlapped. The distributor shall be operated along a stringline or other marked edge.

Heavy duty paper or other suitable material shall be used at transverse junctions of asphalt spreads to prevent excess asphalt application.

Hand-held sprayers shall be used to cover areas not accessible to the distributor.

No asphalt shall be applied to manhole covers, valve covers, etc.

(2) **Aggregates:** Aggregate shall be spread immediately after asphalt is applied. Equipment shall not be allowed on uncovered asphalt. Aggregate shall be spread with a self-propelled spreader capable of uniformly spreading the aggregate at variable widths up to a full traffic lane in 1 application. Hand spreading shall be used in areas inaccessible to spreading equipment.

The surface shall be rolled immediately after aggregate spreading with a pneumatic-tire roller in a longitudinal direction beginning at outer edges, each pass overlapping the previous pass by 1/2 the roller width.

Rolling shall be completed within 1/2 hour after aggregate placement.

The completed seal shall be maintained for 4 days, which includes daily brooming to remove excess aggregate and redistribution of aggregate (or placement of additional aggregate) to absorb free asphalt. Upon completion of the 4-day maintenance, excess aggregate shall be swept from the surface.

404-4 MEASUREMENT: The quantities of asphalt chip seal for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

404-5 PAYMENT: Payment for asphalt surface treatment will be made at the contract unit price per square yard.

404-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
4040100	Type A Asphalt Chip Seal	Square Yard
4040200	Type B Asphalt Chip Seal	Square Yard

405-1

SECTION 405

ASPHALT SLURRY SEAL

405-1 DESCRIPTION: This work consists of furnishing and placing an asphalt slurry seal coat composed of an asphalt/aggregate mixture on an existing asphalt surfaced pavement.

405-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Asphalt (Grade SS-1P)	1003
Aggregates	1001-8
Portland Cement (Type I)	1002-1
Hydrated Lime	1002-3

405-3 CONSTRUCTION:

(a) **Mix Composition:** The mix shall be proportioned as follows:

Residual Asphalt	6-9% by dry wt. of aggregate
Cement or Lime	0.5-3.0% by dry wt. of aggregate
Water	As needed

(b) **Weather Limitations:** Slurry shall not be applied when air temperature is below 60° F.

(c) **Surface Preparation:** Any raised pavement markers shall be removed and the surface cleaned of dirt and loose material. Immediately before slurry is applied, the surface shall be uniformly fog-sprayed with water.

(d) **Application:** Slurry shall be applied with a continuous flow mixer and a spreader box having flexible material in contact with the pavement. Hand squeegees shall be used in areas inaccessible to the spreader box. Slurry shall be applied to pavement at the following rates:

	<u>1-Lift Slurry Seal</u>	<u>2-Lift Slurry Seal</u>
1st Lift	20 lb/sy	30 lb/sy
2nd Lift	25 lb/sy	- - -

(e) **Protection:** Traffic shall not be allowed on the completed slurry seal until it has sufficiently cured to prevent damage.

405-4 MEASUREMENT: The quantity of asphalt slurry seal for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

405-5 PAYMENT: Payment for asphalt slurry seal will be made at the contract unit price per square yard.

405-6

405-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
4050100	1-Lift Asphalt Slurry Seal	Square Yard
4050200	2-Lift Asphalt Slurry Seal	Square Yard

PART V**PAVEMENTS**

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SECTION 501**ASPHALT CONCRETE PAVEMENT**

501-1 DESCRIPTION: This work consists of furnishing and placing hot asphalt concrete plant mixtures.

501-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Asphalt Concrete	1004
Asphalt Tack Coat	1003

Tack coat shall be emulsified asphalt (grade CRS-2P or SS-1P).

501-3 CONSTRUCTION:

(a) **Weather Limitations:** Asphalt concrete shall not be placed on a wet surface or when air temperature is below 45° F, except that material in transit or in surge bins at the time plant operation is discontinued may be laid.

(b) **Surface Preparation:** Any existing raised pavement markers and excess joint filler shall be removed and the surface cleaned of dirt, vegetation and loose material.

On new bases, the prime coat or curing membrane shall be spot patched as necessary.

(c) **Tack Coat:** Contact surfaces of structures (curbs, gutters, manholes, etc.) and edges of previously laid courses shall be lightly coated with asphalt tack coat prior to placing asphalt concrete against them.

Before overlaying existing pavement, asphalt tack coat shall be applied to the surface at the approximate rate of 0.05 gallon per square yard. Tack coat shall also be applied between layers of asphalt concrete.

Tack coat shall be applied on the same day that the asphalt mixture is placed, at a minimum temperature of 160°F for grade CRS-2P, and 70°F for grade SS-1P.

(d) **Joints:** Longitudinal joints shall be constructed by overlapping the paver approximately 2" onto the adjacent pass. Prior to rolling, the overlapped mix shall be pushed back, without scattering loose material over the uncompacted mat, to form a vertical edge above the joint. Longitudinal joints in 1 layer shall offset those in the layer below by approximately 3"; however, the joint in the top layer shall be offset 3" to 6" from the centerline of pavement or lane lines.

Transverse joints shall be formed by cutting back on the previously placed mixture to expose the full depth of the course. Transverse joints in succeeding courses shall be offset at least 2 feet.

(e) **Hauling and Paving:** Mixtures shall be transported from plant to paver at a temperature no cooler than 25°F below the lower limit of the approved job mix formula. No load shall be sent out so late in the day that spreading and compaction of the mixture cannot be completed during daylight, unless artificial lighting has been approved.

Mixtures shall be placed in lifts not exceeding 2" thick, unless thicker lifts are permitted.

Blade graders may be used to fill isolated depressions in the initial layer.

(1) **Coordination of Production:** Sufficient hauling vehicles shall be provided to insure reasonably continuous roadway operations.

(2) **Paving Operations:** All mixtures shall flow through the paver hopper. Mixtures dropped in front of the paver shall be either lifted into the hopper or cast aside. The height of material in front of the screed shall remain uniform.

Transfer of mixture from haul truck to paver may be made by direct unloading into the paver hopper or by approved mechanical devices to transfer mix from a haul truck or windrow. During mixture transfer, the paver shall not be moved out of alignment. During truck exchanges, the level of mix in the paver hopper shall not drop so low as to expose hopper feed slats.

Stringlines or other forms of longitudinal control shall be placed for the paver to follow. Irregularities in alignment shall be corrected by trimming or filling behind the paver.

Screen, tamping bars, feed screws, hopper feed, etc. shall be checked frequently and adjusted as required to assure uniform spreading of the mix to proper line and grade and adequate compaction. When segregation of materials or other deficiencies occur, paving operations shall be suspended until the cause is corrected.

Surface irregularities shall be corrected behind the paver. Excess material forming high spots shall be removed. Indented areas shall be filled and finished smooth. Material shall not be cast over the surface.

When paving and finishing operations are interrupted so that the mixture remaining in trucks, paver, hopper or on the pavement cools to such extent that it cannot be satisfactorily placed, finished or compacted, the cooled mixture shall be removed and replaced at the contractor's expense.

Unless the erected stringline is specified, the 30-foot (minimum) traveling reference plane method of construction shall be used.

The following requirements shall apply for mechanical pavers:

a. **Minimum 30-Foot Traveling Referenced Plane:** The minimum 30-foot traveling reference plane shall consist of at least 8 sensing points with wheels or feet mounted on a frame and moving independently so that the grade reference changes to follow the average reading from all wheels or feet. When the referenced plane is designed for the grade sensor to rest on a 1-piece rigid beam, a piano wire will not be required. When the beam is not monolithic and rigid, a piano wire shall be stretched from end-to-end, so that there is less than 0.1" variance when the grade sensor is in place.

After the initial paving strip of each lift is compacted, adjacent paving strips shall be placed to the grade of the initial paving strip using a traveling reference plane to control grade and a slope control device to control cross slope.

When directed, the shoe device shall be used to control the grade of the initial or adjacent paving strips on any lift. On multilane pavements, the initial paving strip and the sequence of lane construction will be subject to approval.

When both outside edges of the paving strip being placed are flush with previously placed material, the slope control device shall not be used. A grade sensor is required for each side of the paver.

In superelevated curves, the cross slope shall be changed in gradual increments while the paver is in motion so a smooth transition in grade is obtained within the transition distance specified.

b. **Erected Stringline:** An erected stringline shall consist of a piano wire stretched between stakes set at maximum 25-foot intervals tensioned between supports so that there is less than 0.1" variance between supports when the sensor is in place. The initial paving strip of the 1st lift shall be constructed using an erected stringline referenced to established grade. Mixtures used to level isolated depressions may be placed without automatic screed control. Subsequent lifts may be constructed with the traveling reference plane, provided surface and grade tolerances are met on the previous lift.

Only 1 grade sensor and the slope control device are necessary for roadways with normal crown on tangent alignment. Superelevated curves will require the use of 2 grade sensors and 2 erected stringlines to obtain proper grade and slope; however, if the automatic screed control device is equipped with a dial or other device which can change the cross slope in small increments, superelevated curves may be constructed using this device and 1 erected stringline.

501-3

After the initial paving strip of the 1st lift is finished and compacted, adjacent paving strips shall be laid using a minimum 30-foot traveling reference plane.

c. **Without Automatic Screed Control:** Pavers without automatic screed control may be used for patching, widening, drives, turnouts and other irregular areas.

(3) **Hand Placement:** When the use of mechanical finishing equipment is not practical, the mix may be placed and finished by hand. No casting of the mixture will be permitted.

(4) **Compaction:** After placement, mixtures shall be compacted by rolling while still hot. If roller operation is discontinued, rollers shall be removed to cooler areas of the mat where they will not leave surface indentations.

Roller passes shall overlap preceding passes. Nonvibrating steel wheel rollers shall be operated with drive wheels toward the paver. Operations causing displacement, tearing or cracking of the mat shall be immediately corrected.

Equipment which leaves tracks or indented areas which cannot be corrected in normal operations shall not be used. Operation of equipment resulting in shedding of material onto the mat will not be permitted.

To prevent adhesion of mixture, wheels of steel wheel rollers shall be kept properly moistened.

Pneumatic tire rollers shall be operated so that tires will retain adequate heat to prevent mix from adhering to tires. The pneumatic tire roller shall be operated at a contact pressure which will result in a uniform, tightly-knit surface. The pneumatic tire roller shall be kept approximately 6" from unsupported edges of the paving strip; however, when an adjacent paving strip is down, the roller shall overlap the adjacent paving strip approximately 6".

Mixtures that become loose, broken, contaminated or otherwise defective shall be removed and replaced with new mixture.

After finish rolling, the pavement shall be protected from traffic until it has hardened. The finished pavement shall have a tightly knit surface free of cracks, tears, ripples or other deficiencies. The contractor shall correct such deficiencies and adjust his operations to eliminate the problem on subsequent pavements. The contractor shall repair any area damaged by traffic.

(5) **Sawing and Sealing Joints:** When specified, joints shall be sawed and sealed in asphalt concrete overlays of portland cement concrete at existing transverse and longitudinal joints. Sealant shall conform to Subsection 1007-2.

501-4

501-4 ACCEPTANCE REQUIREMENTS:

(a) **General:** Sampling and testing for acceptance will be conducted on each lot of pavement for thickness, density and surface tolerance; however, thickness deficiencies of leveling courses will be waived. Any pavement that is obviously deficient shall be satisfactorily corrected or removed and replaced.

An asphalt concrete pavement lot is an identifiable area of approximately 4,000 square yards of the same mixture paid under one item. The final area of pavement placed will be considered as a lot if it is at least 2,000 square yards; otherwise, it will be included in the previous lot.

(b) **Thickness and Density:** Thickness and density of the pavement will be determined from cores approximately 4" in diameter. Each lot will be divided into 5 equal segments and 1 core will be obtained from each segment.

Core holes shall be patched by the contractor with new mixture.

(1) **Thickness:** Average thickness of the pavement lot shall not be less than the specified thickness by more than 1/4". In calculating average pavement thickness, cores in excess of specified thickness by more than 1/4" will be considered as specified thickness plus 1/4".

(2) **Density:** Average density of the pavement lot shall be at least 95% of maximum density determined by DOTD TR 304.

(3) **Small Projects:** On projects with less than 2,000 square yards, the number of cores may be reduced by the engineer.

(c) **Surface Tolerance:** The contractor shall furnish a 10-foot rolling straightedge for longitudinal testing and a 10-foot static straightedge for transverse testing, both acceptable to the engineer. The rolling straightedge shall be calibrated and used in accordance with DOTD TR 603 and TR 618.

One path in each lane will be selected by the engineer for longitudinal testing. The contractor shall assist the engineer in pulling the rolling straightedge. Longitudinal and cross-slope variations shall not exceed that specified by more than 1/2".

501-5 MEASUREMENT: Asphalt concrete pavement will be measured by the ton from printed weights. Stamped printer tickets will be issued for each truckload of material delivered. Material lost, wasted, rejected or applied contrary to specifications will not be measured for payment. Asphalt tack coat will not be measured for payment.

Sawing and sealing asphalt pavement joints will be measured by the linear foot.

501-6

501-6 PAYMENT: Payment for asphalt concrete payment will be made at the contract unit price per ton, which includes furnishing all required material, producing the mixtures, preparing the

surfaces on which the mixtures are placed, hauling the mixtures to the work site, and placing and compacting the mixtures.

Payment for saving and sealing asphalt pavement joints will be made at the contract unit price per linear foot.

501-7 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
5010100	Asphalt Concrete Pavement	Ton
5010200	Polymerized Asphalt Concrete Pavement	Ton
5010300	Saw and Seal Asphalt Pavement Joints	Linear Foot

SECTION 502

PORTLAND CEMENT CONCRETE PAVEMENT

502-1 DESCRIPTION: This work consists of furnishing and constructing portland cement concrete pavement.

502-2 MATERIALS: Materials shall conform to the following Sections or Subsections:

Portland Cement Concrete	
(Class 5.5B3800 or 5.25D3800)	1005
Joint Materials	1007
Tie Bars	1006-3
Dowel Bars	1006-4
Curing Compound	1008-4

502-3 ROADBED PREPARATION: After the roadbed has been graded and compacted, the grade shall be trimmed to the correct elevation, extending the work at least 1 foot beyond each edge of the proposed concrete pavement and to a greater width as necessary when the slip form paving method is used.

502-4 FORMS: Forms shall be metal and headers shall be of timber. They shall be set firm and true to line and grade for a distance of at least 1 day's run of concrete in advance of placing the pavement. They shall be oiled immediately prior to placing concrete and shall remain in place for at least 12 hours after concrete has been placed, but must be removed before the work is accepted.

Straight side forms shall be made of metal and shall be furnished in sections not less than 10 feet in length. On long curves straight forms of shorter length will be permitted. Forms shall have a depth of not less than the specified pavement thickness and a base width of at least 0.8 of the depth. Flexible or curved forms of a proper radius shall be used on curves of 100 feet radius or less. Forms shall be provided with adequate devices for secure setting. Flange braces shall extend outward on the base not less than 2/3 the height of forms. Forms with battered top surfaces and bent, twisted or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Top face of forms shall not vary from a true plane more than 1/8" in 10 feet, and the upstanding leg shall not vary more than 3/8" from the vertical. Forms shall contain provisions for locking ends of abutting form sections together tightly.

Foundation under forms shall be firm and true to grade so that form will be firmly in contact for its whole length and at specified grade.

On asphalt concrete or soil cement base courses, each form section shall be staked into place with at least 2 pins installed in fullsize drilled holes.

On other types of bases or subbases, at least 3 pins will be required in each form section. After forms have been set to correct grade and alignment, the base or subbase shall be thoroughly tamped at both

inside and outside edges of forms.

Alignment and grade of forms shall be checked and corrections made prior to placing concrete. When any form has been disturbed or the grade or alignment has become unstable, the form shall be reset and rechecked. Form sections shall not deviate from required alignment by more than 3/8".

Alternate methods of forming, such as the use of slip forms, may be used.

502-5 JOINTS:

(a) **Longitudinal Joint (Type LJ):** The longitudinal joint shall be constructed such that the transverse joint is continuous across the slab. Deformed steel tie bars shall be placed perpendicular to longitudinal joints by approved mechanical equipment or rigidly secured by chairs or other approved supports. Tie bars shall not be coated with asphalt or other material or enclosed in tubes or sleeves. With split-slab construction, only Grade 40 tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before concrete of the adjacent lane is placed.

Tie bars which break or show evidence of fracture upon straightening shall be replaced by using an adhesive anchor system listed in the QPL or an epoxy resin system.

The joint shall be formed by either of the following methods:

(1) **Sawing:** Sawing shall begin as soon as concrete has reached sufficient strength to support sawing equipment and tearing of concrete does not occur. Sawing shall be completed within 10 hours of placing concrete.

The joint sealant shall conform to Subsection 1007-2(b) or (c).

After each joint is sawed, the saw cut and adjacent concrete surfaces shall be cleaned of materials removed during sawing.

No equipment, other than the sawing machine, will be permitted on the pavement during sawing. Sufficient back-up equipment shall be provided at the jobsite to continue sawing operations in case of a breakdown of primary sawing equipment.

During paving operations, joint locations shall be clearly marked.

(2) **Preformed Filler:** Joint filler material conforming Subsection 1007-1(c) or (d) shall be inserted in a groove formed by a "T" iron wheel or other device that will ensure a groove that is true in both vertical and horizontal alignment. Grooves shall be cut in such manner that the concrete surface will not be depressed or otherwise disturbed. After insertion, the top edge of the strip shall be flush with the pavement surface and the surface floated.

502-5

(b) **Longitudinal Construction Joint (Type LCJ):** Longitudinal construction joints shall be constructed when adjacent lanes are constructed separately. Hand vibrators shall be used to consolidate concrete adjacent to joints. Joints shall include tie bars. Tie bars shall be protected from being coated with curing compound.

(c) **Longitudinal Butt Joint (Type LBJ):** Longitudinal butt joints shall be constructed when adding additional lanes of pavement. Deformed tie bars shall be placed perpendicular to joints. Tie bars shall not be coated with asphalt or other material or enclosed in tubes or sleeves.

Tie bars shall be installed in holes drilled in existing pavement using an adhesive anchor system listed in the QPL or an epoxy resin system.

(d) **Transverse Expansion Joint (Type EJ):** Filler shall be wood conforming to Subsection 1007-1(b), and sealer shall be a preformed elastomeric compression seal conforming to Subsection 1007-3 or a pourable sealer conforming to Subsection 1007-2(c).

The wood filler shall be saturated with water before installation.

Dowel bars shall provide bracing adequate to hold wood filler in a vertical position.

(e) **Transverse Dummy Joint (Type DJ):** Transverse dummy joints shall have dowel bars, shall be clearly marked during paving operations, and shall be formed by either of the following methods.

(1) **Sawing:** Sawing shall begin as soon as concrete has reached sufficient strength to support sawing equipment and tearing of concrete does not occur. Sawing shall be completed within 10 hours of placing concrete. When joint cannot be sawed to pavement edge due to form, an insert shall be placed in the 6" adjacent to forms.

Saw cut and adjacent concrete surfaces shall be cleaned of materials removed during sawing.

No equipment, other than the sawing machine, will be permitted on the pavement during sawing. Sufficient back-up equipment shall be provided at the jobsite to continue sawing operations in case of a breakdown of primary sawing equipment.

Joints shall be sealed with performed elastomeric compression seals conforming to Subsection 1007-3 or pourable sealer conforming to Subsection 1007-2(b) or (c).

(2) **Combination Former/Sealer:** A groove shall be made in the fresh concrete at the joint location with a "T" iron or other suitable device. A combination joint former/sealer conforming to Subsection 1007-4 shall be immediately installed and the concrete vibrated on each side. Top cap of the former/sealer shall remain in place until after final clean-up.

502-6

(f) **Transverse Construction Joint (Type CJ):** A transverse construction joint shall be

constructed when concreting is interrupted for over 1 hour, provided it is not within 10 feet of another transverse joint. If joint would be within 10 feet of another transverse joint, concrete shall be removed back to preceding joint.

Transverse construction joints shall include dowel bars and shall be formed and sealed as specified in Subsection 502-5(e).

(g) **Transverse Butt Joint (Type BJ):** Transverse butt joints shall be used when extending existing pavement. Dowel bars shall be installed in existing pavement by drilling holes 1/8" larger than the bar diameter and using an adhesive anchor system listed in the QPL or an epoxy resin system. Joint shall be formed and sealed as specified in Heading (e).

(h) **Dowel Bars:** Dowels may be placed by a mechanical device equipped with means to control depth and alignment of bars. Dowel bars shall be positioned parallel to pavement centerline and surface and shall be held in position by the mechanical device until concrete has been consolidated around bars.

Dowel bar assemblies shall have an expansion tube on each bar in expansion joints. Sleeve shall fit bar tightly and closed end shall be watertight.

502-6 PLACING CONCRETE: Subgrade or base shall be sprinkled to dampen the surface, but method of sprinkling shall not form mud or pools of water. Concrete shall be deposited in such manner as to require as little rehandling as possible. Placing shall be continuous between transverse joints without the use of intermediate bulkheads.

Necessary hand spreading shall be done with shovels or other approved tools, excluding rakes and vibrators. Workers shall not walk in freshly mixed concrete with boots coated with dirt or foreign substances.

When concrete is to be placed adjacent to newly constructed pavement and equipment will be operated on the new pavement, the new pavement shall have attained an age of at least 10 days or a compressive strength of 3,000 psi.

When only finishing equipment is carried on newly constructed pavement, paving of adjoining pavement will be permitted after 3 days.

Concrete shall be placed as near to joints as possible without disturbing them.

502-7 CONSOLIDATION AND FINISHING:

(a) **Consolidation:** Concrete shall be vibrated for the full width and depth of slab. Vibrators shall be operated no longer than 15 seconds in one location. Care shall be taken to assure consolidation of concrete against joint material and around dowel bars and tie bars.

502-8

(b) **Screeding:** Concrete shall be screeded with an approved portable screed moved

forward on forms with a combined longitudinal and transverse shearing motion, moving in the direction in which work is progressing and so manipulated that neither end is raised from side forms. This shall be repeated until the surface is of uniform texture, true to grade and cross section and free from porous areas. The screed shall be controlled to maintain a uniform roll of concrete ahead of the screed.

(c) **Floating:** Floating to provide the final surface will be required using a machine float. Following machine floating, longhandled floats may be used to smooth and fill open-textured areas. Longhandled floats shall not be used to float the entire pavement surface in lieu of machine floating unless the pavement crown will not permit use of the machine float.

(d) **Straightedging:** Excess water and laitance shall be removed from the pavement surface by a steel straightedge. The entire plastic concrete surface shall be tested for trueness with a straightedge held in contact with the surface in successive positions parallel to pavement centerline. Depressions shall be immediately filled with freshly mixed concrete, struck off and refinished. High areas shall be cut down and refinished.

(e) **Final Texturing:** After surface irregularities have been removed and a satisfactorily smooth surface obtained, concrete shall be textured with a metal tine device.

Grooves produced in concrete shall be spaced on 1" centers and shall be 3/16" wide and 1/8" to 3/16" deep. Grooves shall be transverse to roadway centerline.

(f) **Edging:** After drag finishing and before concrete has reached initial set, pavement edges and joint edges requiring rounding shall be tooled. Tool marks adjacent to joints shall be removed by brooming.

(g) **Hand Finishing:** Concrete shall be hand finished only in the following cases:

(1) In case of breakdown of mechanical finishing equipment, concrete already placed may be hand finished.

(2) Pavement widths less than 10 feet.

(3) Areas of irregular dimensions.

(4) Pavement to be overlaid with asphalt concrete.

502-8 SLIP-FORM PAVING: Slip-form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape and strength to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section, and it shall satisfactorily spread, consolidate, screed and float the fresh concrete.

502-9

The full width of concrete paving shall be internally vibrated. Vibratory placement of dowel bars and tie bars shall occur within trailing forms. Vibration shall be stopped when slip-form paver stops.

Pavement edges shall not deviate more than 1/2" from specified alignment.

When concrete is placed adjacent to existing pavement, that part of equipment supported on existing pavement shall have rubber tires or shall have protective pads on crawler tracks, offset to run a sufficient distance from pavement edge to avoid breaking the edge.

Concrete shall be given the final surface finish in accordance with Subsection 502-7(e).

502-9 CURING AND PROTECTION:

(a) **Curing:** Concrete shall not be left exposed for more than 1/2 hour during the curing period. Curing shall be maintained for 72 hours. The pavement surface shall be uniformly sprayed with curing compound immediately after completion of surface finishing and as soon as surface water evaporates. Curing compound shall not be applied during rainfall.

Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer. Spraying equipment shall be of the fully atomizing type equipped with a tank agitator. During application, compound shall be stirred continuously by mechanical methods. Hand spraying of irregular shapes and surfaces exposed by form removal will be permitted provided compound has been agitated prior to placing in sprayer. Compound shall not be applied to inside faces of joints to be sealed. In split slab construction, compound shall be so applied as to prevent spraying exposed tie bars.

When side forms are removed before the end of the curing period, exposed sides of slabs shall be immediately protected by applying curing compound.

(b) **Rain Protection:** During paving operations, the contractor shall have at the jobsite sufficient polyethylene sheeting to protect the last hour's concrete from rain damage.

(c) **Cold Weather Protection:** When air temperature is expected to reach the freezing point during the curing period, straw or other approved protective material shall be spread over the pavement to a sufficient depth to prevent concrete from freezing.

502-10 SEALING JOINTS: Joints shall not be sealed until at least 7 days after concrete is placed. Pavement may be opened to traffic prior to sealing provided insert has not been removed or sawed. After sealing joints, the pavement shall be closed to traffic until the next day.

Joints shall be cleaned immediately prior to sealing. Silicone sealants require joint faces to be sandblasted immediately prior to sealing. Sandblasting is not required for preformed compression seal except when joint insert is sawed.

502-11

(a) **Preformed Compression Seal:** Preformed compression seals will only be permitted with full-width paving. When adhesive-lubricant is to be pumped, a maximum of 30% dilution with a material recommended by the manufacturer will be allowed. Adhesive-lubricant shall be applied just prior to installation of seal and shall be sufficient to completely cover seal's sidewalls.

Stretching of seal shall not exceed 5%. Field splicing will not be allowed.

(b) **Silicone Sealant:** Joint faces shall be dry and dust free prior to sealant installation. Air temperature at time of placement shall be at least 50° F. Backer material shall be placed as shown in the plans.

The material shall be forced against joint walls by approved methods.

502-11 ACCEPTANCE REQUIREMENTS:

(a) **General:** Sampling and testing for acceptance will be conducted on each lot of pavement for thickness, compressive strength and surface tolerance. Any pavement that is obviously deficient shall be satisfactorily corrected or removed and replaced.

A concrete pavement lot is an identifiable area of approximately 4,000 square yards paid under the same item. The final area of pavement placed will be considered as a lot if it is at least 2,000 square yards; otherwise, it will be included in the previous lot.

(b) **Thickness and Compressive Strength:** Strength and thickness of pavements will be determined from hardened concrete cores in accordance with DOTD TR 225. Each lot will be divided into 5 equal segments and 1 core will be obtained from each segment.

Core holes shall be patched by the contractor using an approved mixture. Surface of the patch shall be finished to match surrounding pavement.

(1) **Thickness:** Average thickness of the pavement lot shall not be less than the specified thickness.

(2) **Compressive Strength:** The compressive strength of cores will be determined after a minimum of 28 days. Average compressive strength for the lot shall be at least 3,800 psi.

(3) **Small Projects:** Projects with less than 2,000 square yards of pavement may be cored as required in Headings (1) and (2) above, or may be accepted on the basis of compressive strength cylinders and thickness measurements taken by the engineer.

(c) **Surface Tolerance:** The contractor shall furnish a 10-foot rolling straightedge for longitudinal testing and a 10-foot static straightedge for transverse testing, both acceptable to the engineer. The rolling straightedge shall be calibrated and used in accordance with DOTD TR 603 and TR 618.

502-12

One path in each lane will be selected by the engineer for longitudinal testing. The contractor shall assist the engineer in pulling the rolling straightedge. Longitudinal and cross-slope variations shall not exceed that specified by more than 1/2". Pavement areas not meeting this tolerance shall be corrected as directed.

502-12 MEASUREMENT: The quantities of portland cement concrete pavement for payment will be the design quantities specified in the plans, adjusted as required due to plan errors or plan changes. Design areas of pavement are based on the horizontal dimensions shown on the plans.

502-13 PAYMENT: Payment for portland cement concrete pavement will be made at the contract unit price per square yard, which includes furnishing and placing concrete, finishing, curing, forming, joint material, dowel bars and tie bars.

502-14 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
50201--	___" Portland Cement Concrete Pavement	Square Yard

PART VI
STRUCTURES

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SECTION 601

CONCRETE STRUCTURES

601-1 DESCRIPTION: This work consists of furnishing, placing, finishing and curing portland cement concrete in bridges and other structures.

601-2 MATERIALS: Materials shall conform to the following Sections or Subsections:

Portland Cement Concrete	1005
Precast Concrete Bridge Deck Units	1009
Precast Prestressed Concrete Girders	1009
Reinforcing Steel	1006-1
Concrete Curing Compound	1008-1
Applied Finish Coating	1008-3
Joint Fillers and Sealants	1007

If class of concrete is not specified, Class 6A4000 shall be used. Compressive strength will be determined from cylinders made in accordance with ASTM C 31 and tested by ASTM C 39.

601-3 PREPARATION OF FOUNDATION: Excavation for structures shall conform to Section 203.

Earth on which concrete is placed shall be firm and free from water. Ground water shall be kept below foundation grade until concrete has set. When foundation is in dry earth, it shall be moistened with water from a spray nozzle immediately before concrete is placed.

601-4 FORMS: Forms shall be of a type, size, shape, quality and strength to enable construction as designed. Forms shall be true to line and grade, mortartight and sufficiently rigid to resist distortion. Responsibility for their adequacy shall rest with the contractor.

Dirt, chips, sawdust, nails and other foreign matter shall be removed from forms before concrete is placed. Surfaces of forms shall be smooth and free from irregularities, dents, sags and holes.

Forms previously used shall be cleaned of dirt, mortar and foreign matter before being re-used.

Before concrete is placed, inside surfaces of forms shall be treated with a release agent that will not discolor concrete.

Forms for exposed surfaces shall be made of surfaced lumber or material which will provide a surface equally satisfactory.

Forms for exposed surfaces of bridges, viaducts, overcrossings and similar structures shall be constructed of plywood or approved equal.

Plywood for forms shall be Exterior B-B (Concrete Form) grade conforming to American Plywood Association specifications. Plywood shall be furnished and placed in 4-foot widths and 8-foot lengths, except where dimension of member formed is less than specified panel dimension. Plywood shall be placed with grain of outer plies in direction of span. Where plywood is attached to studding or joists, panels shall be at least 5/8" thick, and studdings or joists shall be spaced not more than 12" center to center. Form panels shall be placed in a neat, symmetrical pattern with horizontal joints level and continuous.

Wood forms for copings and curbs shall have a thickness not less than 1-5/8" and a width not less than depth of coping or curb.

Sharp edges shall be chamfered with 3/4" x 3/4" triangular fillets. Forms for curved surfaces shall be so constructed and placed that finished surface will not deviate from arc of curve.

Forms shall be so constructed that portions where finishing is required may be removed without disturbing portions of forms to remain.

Forms for girders and slabs shall be cambered as directed.

Forms shall be so constructed that form marks will conform to general lines of structure.

Approved form clamps or bolts shall be used to fasten forms. Use of twisted wire loop ties or wood spreaders to hold forms in position will not be permitted. Clamps or bolts shall be of sufficient strength and number to prevent spreading of forms. They shall be of such type that they can be entirely removed or cut back 1/2" below finished surface of concrete. Forms for outside surfaces shall be constructed with stiff wales at right angles to studs and form clamps shall extend through and fasten such wales.

601-5 FALSEWORK: The contractor shall prepare plans for falsework and submit them to the engineer for review. These plans shall be stamped by a Registered Professional Civil Engineer.

601-5

For designing falsework, a weight of 150 pounds per cubic foot shall be assumed for concrete and a minimum of 30 pounds per square foot for construction load. Falsework shall be designed and constructed to support loads without settlement or deformation.

Falsework which cannot be founded on a satisfactory footing shall be supported on piling spaced, driven and removed in an approved manner. Falsework shall be set to give finished structure specified camber.

601-6 REMOVAL OF FORMS AND FALSEWORK: Surfaces requiring a Class 2 finish shall be removed not less than 1 nor more than 2 days after concrete placement. Other non-supporting forms may be removed after concrete has been in place for at least 1 day.

Supporting forms and falsework may be removed as soon as concrete has attained at least 75% of required 28-day compressive strength.

601-7 PLACING REINFORCEMENT: Before placing reinforcing steel, a list of all reinforcing steel shall be furnished to the engineer.

Reinforcing bars shall be securely held in position by wiring at intersections and elsewhere as necessary to prevent shifting of bars, with wire not smaller than No. 16, and by using concrete or metal chairs, spacers, metal hangers or other approved devices. Metal chairs in contact with exterior surfaces shall be plastic-coated or stainless steel. Layers of bars shall be separated by approved devices. Use of pebbles, broken stone or brick, metal pipe and wood blocks will not be permitted.

Before placing steel in forms, steel shall be thoroughly cleaned of mortar, oil, dirt, loose mill scale, loose or thick rust and coatings that would reduce the bond. No concrete shall be deposited until placing of reinforcing steel has been inspected and approved.

601-7.1 Splicing: Reinforcement shall be furnished in full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without written approval. Splices shall be staggered as far as possible. Minimum length of splice lap shall be as follows:

<u>Bar Size</u>	Lap Splice Lengths (inches)	
	<u>Grade 40 Steel</u>	<u>Grade 60 Steel</u>
3	12	18
4	16	24
5	20	30
6	26	39
7	35	53
8	46	69
9	58	88
10	74	111
11	91	137

Welding of reinforcing steel will not be permitted.

601-7

601-7.2 Bending Reinforcement: Bends and hooks in bars shall be made as prescribed in the Concrete Reinforcing Steel Institute's "Manual of Standard Practice."

Bars shall not be bent nor straightened in a manner that will damage the material. Bars with kinks or unspecified bends shall not be used.

601-7.3 Welded Wire Fabric: Fabric shall be held firmly in place. Fabric shall be spliced not less than 2 meshes.

601-8 PLACING CONCRETE:

601-8.1 General: Concrete shall be placed so as to avoid segregation of materials and displacement of reinforcement. Fresh concrete shall not be permitted to fall more than 6 feet without use of a tremie.

Except for concrete placed in slope paving and aprons, and concrete placed under water, concrete shall be compacted by high-frequency internal vibrators of approved type and size. Number of vibrators used shall be ample to properly consolidate concrete within 15 minutes after it is placed. Vibrators shall not be held against forms or reinforcing steel. Locations, manner and duration of application of vibrators shall be such as to secure maximum consolidation of concrete without causing segregation of mortar and coarse aggregate, and without causing water or cement paste to flush to surface. Concrete shall be spread in horizontal layers not more than 12" thick. If additional concrete is to be placed, laitance shall be removed and concrete surfaces roughened.

Concrete shall be consolidated until voids are filled and mortar appears on surface. Concrete shall be placed as nearly as possible in final position; use of vibrators for shifting concrete will not be permitted.

Use of external vibrators for compacting concrete will be permitted when concrete is inaccessible for internal compaction, provided forms are sufficiently rigid to resist displacement or damage from external vibration.

Methods of compaction used shall result in a surface of even texture free from voids, water or air pockets and force coarse aggregate away from forms in order to leave a mortar surface.

When chutes are used they shall be sloped to permit flow of concrete at required consistency. Use of additional water in concrete to promote flow in chutes will not be allowed. Where necessary to prevent segregation, chutes shall be provided with baffles or a reversed section at outlet. Columns shall be poured through pipes of adjustable length and not less than 6" diameter.

Horizontal sections shall not be placed until concrete in supporting vertical sections has been consolidated.

601-8

Walkways shall be provided along each side for full length of bridge structures outside deck area. Walkways shall be of sufficient width and so constructed as to provide for support of bridges from

which longitudinal floats are to be operated. Inspection walkways and access thereto shall be provided under deck forms between each pair of girders and outside each exterior girder for full length of bridge. Walkways shall be not more than 8 feet below concrete to be inspected.

Traffic shall not be permitted on bridge decks until concrete has attained required 28-day compressive strength.

601-8.2 Joints: The work shall be so prosecuted that construction joints occur at specified locations, unless permitted otherwise. The contractor shall complete, by continuous depositing of concrete, sections of the work between such joints. Joints shall be kept moist until adjacent concrete is placed.

Construction joints at bottom of walls or arches, at top of walls, and longitudinal construction joints having a keyed, stepped or roughened surface shall be cleaned by sand-blasting or other approved methods prior to pouring adjacent concrete.

Cleaning operations shall be continued until unsatisfactory concrete, laitance, coating, stains, debris and other foreign materials are removed. Concrete surface shall be washed thoroughly to remove loose material. Method of disposing of wash water shall be such that waste water will not discolor exposed surfaces of structures.

Horizontal construction joints and those on slight slopes shall be covered with mortar.

Expansion joints shall be formed where shown on the plans or as directed. Such joints shall have smooth abutting surfaces. No reinforcement shall be extended through joints, except where shown on the plans.

Hardened concrete surfaces of vertical construction joints shall be blast cleaned and coated with a Type II, Grade C epoxy resin listed in the QPL in accordance with the manufacturer's instructions immediately prior to placing adjacent concrete.

601-8.3 Weather Limitations: Concrete shall not be placed on frozen ground nor while air temperature is below 40°F and falling nor resumed until temperature is above 35°F and rising. Concrete shall be protected from freezing for at least 5 days after placing.

Placing concrete shall be stopped when rainfall is sufficient to cause a flow or wash the surface.

Concrete which has become damaged shall be replaced by and at the expense of the contractor.

601-8.4 Girders, Slabs and Columns: Concrete in girders shall be deposited uniformly for full length of girder.

601-8

Concrete in girder haunches less than 3 feet high shall be placed at same time as girder web. Column or abutment tops shall be cut back to form seats for haunches. When a haunch or fillet has a vertical height of 3 feet or more, abutment or columns, haunch and girder shall be placed in 3 stages; up to lower side of haunch, to lower side of girder, and to completion. For haunched continuous girders,

girder web (including haunch) shall be placed to top of web. Where size of pour is such that it cannot be made in a continuous operation, vertical construction joints shall be located within area of contraflexure.

Concrete in each slab span shall be placed in a continuous operation.

Concrete T-beam or deck girder spans may be placed in a continuous operation, or in 2 separate operations, each of which shall be continuous: to top of girder webs, and to completion. In the latter case, bond between stem and slab shall be secured by shear keys or roughening top of girder stem. Keys shall be formed by using 2" x 4" timber blocks having a length 4" less than width of girder stem, spaced along girder stems not more than 1 foot center to center.

Blocks shall be beveled and oiled to facilitate their removal, and shall be removed as soon as concrete has set sufficiently to retain its shape.

Concrete columns shall be placed in a continuous operation. Concrete shall be allowed to set at least 24 hours before caps are placed. When friction collars are used to support cap forms, concrete columns shall have been poured at least 7 days before caps are placed.

No concrete shall be placed in superstructure until column forms have been stripped sufficiently to determine character of concrete in column. Load of superstructure shall not be allowed to come upon bents until bents have attained at least 3,000 psi compressive strength.

601-8.5 Railings: Forms and reinforcing steel for concrete railings shall not be placed until at least 3 days after deck slab is placed. Curing compounds will not be permitted on railings.

Barrier, railing and curbs shall be normal to roadway cross slope and grade. Expansion joints shall be so constructed as to permit freedom of movement. After the work is completed, mortar likely to spall under movement shall be removed. Concrete barrier or railing shall not be placed until span is self-supporting. On continuous spans, railing or barriers shall not be placed until deck of continuous unit is completed.

601-8.6 Placement Rate for Bridge Decks: Concrete shall be placed at the following rates.

<u>Pour Size</u> <u>Cubic Yards</u>	<u>Minimum Placement Rate</u> <u>Cubic Yards Per Hour</u>
0-25	15
26-50	20
51-75	25
76-125	30
Over 125	40

601-8

601-8.7 Pumping: Pumping equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. Pipes carrying concrete to placing area shall be laid out with a minimum of bends and no unauthorized change in size. Aluminum piping will not be permitted. A grout mortar, or concrete with coarse aggregate omitted, shall be pumped through equipment ahead

of regular concrete to provide lubrication to start pumping operations. This material shall not be used in placement.

Operation of pump shall be such as to provide a continuous stream of concrete without air pockets. When pumping is completed, concrete remaining in pipes, if used, shall be ejected in such manner that there will be no contamination or segregation of concrete.

601-8.8 Underwater Placement: Concrete shall not be placed in water except on approval.

Concrete shall be placed with a tremie and shall not be disturbed after being deposited. Concrete shall be placed in caissons, cofferdams or watertight forms.

For underwater parts of structures, concrete seals shall be placed in a continuous operation. Surface of concrete shall be kept horizontal; still water shall be maintained at point of deposit.

A tremie shall consist of a tube at least 10" in diameter; if constructed in sections, couplings shall be watertight. Tremies shall be supported so as to permit positioning anywhere over surface of the work and for rapid lowering to retard or stop flow of concrete.

When concrete is dumped into hopper, flow may have to be induced by slightly raising discharge end of tremie, but always keeping it in deposited concrete. Flow shall be continual until the work is completed. Aluminum tremies will not be permitted.

Dewatering shall not be accomplished until at least 72 hours after concrete placement. Prior to constructing succeeding portions of structure, laitance or other unsatisfactory material shall be removed.

601-9 CURING: Immediately after finishing, exposed concrete surfaces shall be covered with curing materials.

Surfaces requiring a Class 2 finish shall be cured with wet burlap. Bridge decks shall be cured with a Type 2 curing compound. All other surfaces shall be cured with either wet burlap or a Type 1-D curing compound. When burlap is used, surface shall be covered with 2 layers of burlap kept wet and in contact with concrete for at least 5 days.

When curing compound is used, it shall be applied in accordance with Subsection 502-9.1. Reinforcing steel and joints shall be covered or shielded to prevent contact with curing compound.

601-10 SURFACE FINISHES: Surface finishes shall be classified as follows:

601-10

Class 1	Ordinary Surface Finish
Class 2	Applied Coating Finish
Class 3	Exposed Aggregate Finish
Class 4	Bridge Deck Finish
Class 5	Sidewalk Finish
Class 6	Precast-Prestressed Concrete Finish

All exposed concrete shall be given Class 1, Ordinary Surface Finish, in addition to other type of finish specified.

The following surfaces shall be given a Class 2 finish: exposed faces of wingwalls, retaining walls, railings and parapets; outside faces of caps and columns. Wingwalls shall be finished from top to 1 foot below finish slope lines on exposed face and from top for a depth of 1 foot below top on backfill sides.

When a Rubbed Finish is specified, a Class 2 finish shall be used.

601-10.1 Class 1, Ordinary Surface Finish: Immediately after removal of forms, fins and irregular projections shall be removed from all surfaces except those which will not be exposed to view. Cavities produced by form ties and other holes, honey-combed spots, broken corners or edges and other defects shall be cleaned and, after having been kept saturated with water, shall be pointed and trued with a mortar of cement and fine aggregate.

Mortar used in pointing shall be not more than 1 hour old. Joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

Surfaces shall be true and uniform. Surfaces which cannot be satisfactorily repaired shall be coated as specified for Class 2 finish.

Exposed surfaces not protected by forms shall be struck off with a straightedge and finished with a wood float to a true, even surface. Use of additional mortar to provide a grout finish will not be permitted.

601-10.2 Class 2, Applied Coating Finish: Coating shall be applied in accordance with the manufacturer's recommendations after all work which might mar surface is complete and finish application can be done in a continuous operation for the structure.

601-10.3 Class 3, Exposed Aggregate Finish: After 28 days, concrete surface shall be sandblasted to produce a surface in which mortar has been cut away, leaving aggregate exposed.

601-10.4 Class 4, Bridge Deck Finish:

(1) **Striking Off:** Bridge decks or top slabs of structures serving as finished pavements shall be finished either by hand methods or mechanical machines. Continuous span units shall be struck off with mechanical equipment.

601-10

When hand methods are used, bridge decks shall be struck off with a screed parallel to roadway centerline, resting on bulkheads or screed strips set to required roadway cross section. Screed shall have sufficient strength to retain its shape, and cutting edge shall be adjusted to conform to roadway profile. Screed shall be of sufficient length to finish full length of spans up to 50 feet.

Spans over 50 feet in length and continuous spans shall be placed with lengths of pours as shown on

the plans. Screed strips or headers shall be set to specified grades, checked and adjusted as necessary prior to final screeding. Screed shall be mechanically operated back and forth over surface until proper profile and cross section are obtained.

Mechanical finishing machines shall be power driven machines, traveling on rails, equipped with transverse or longitudinal screeds and adjusted to conform to profile or cross section. Consolidation by vibratory action of finishing machine will not be permitted. Screeds shall have sufficient strength to retain their shape after adjustment. Finishing machine shall go over each area of bridge deck as many times as required to obtain required profile and cross section. A slight excess of concrete shall be kept in front of screed and carried to edge and wasted.

Excess water, laitance or foreign materials brought to surface during finishing shall be removed.

Application of water to surface shall be by fog spray.

(2) **Straightedging:** After striking off, surface shall be checked by the contractor with a 10-foot metal static straightedge operated parallel to centerline of bridge and shall show no deviation in excess of 1/4". Deviations in excess of this requirement shall be corrected before final finishing. Checking operation shall progress by overlapping straightedge at least 1/2 the length of preceding pass. Major deviations shall be corrected by the strike-off, with straightedge being used to correct minor deviations and as a checking device.

(3) **Final Texturing:** After surface irregularities have been removed and a satisfactorily smooth surface obtained, concrete shall be textured with a metal tine device.

Grooves produced in concrete shall be spaced on 1" centers and shall be 3/16" wide and 1/8" to 3/16" deep. Grooves shall be transverse to roadway centerline and shall extend to within 1 foot of gutterline.

601-10.5 Class 5, Sidewalk Finish: After concrete has been placed, it shall be consolidated and surface struck off with a strike board and floated with a wood or cork float. Edges at expansion joints shall be tooled. Surface shall have a granular texture.

601-10.6 Class 6, Precast Concrete Finish: Precast bridge members shall be given a Class 1 finish at plant as soon as possible after casting.

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After completion of structure, construction damage shall be repaired so as to restore the Class 1 finish. Exposed surfaces of concrete piles shall be cleaned to produce a uniform color.

During pouring of decks, the contractor shall keep girders, pilings and columns clean by washing and shall remove materials that adhere to surface.

601-11 MEASUREMENT:

(a) **General:** Quantities for payment will be the design quantities as specified on the plans, adjusted as required due to plan errors or plan changes.

(b) **Concrete:** Design volumes of concrete are computed from neat plan dimensions with the following modifications. Deductions are made for volumes occupied by fillets, scorings and chamfers with cross-sectional areas over 1 1/2 square inches, expansion joints, and embedded structural steel and piling. Volumes deducted for embedded piling are based on 12" butt diameter timber piling and nominal butt dimensions for other types of piling.

No deductions are made for volumes occupied by fillets, scorings and chamfers with cross-sectional areas not over 1 1/2 square inches, reinforcing steel, water piping, electrical conduit, weep holes and drain piping.

(c) **Reinforcing Steel:** Design quantities are based on theoretical weights of nominal size plain round bars as follows:

<u>Weight Bar No.</u>	<u>Lb/Lin Ft.</u>
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.650
18	13.600

The following will not be included in pay quantities:

- (1) Reinforcement furnished for testing.
- (2) Reinforcement used for laps in splices other than those shown on the plans.
- (3) Additional weight of reinforcement used at the contractor's request as substitutions for reinforcement shown in the plans.

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(4) Spacers, clips, chairs and other material used in fastening reinforcement in place.

(d) **Approach Slabs:** Design quantities are based on horizontal plan dimensions. Reinforcing steel, bolster blocks, geotextile fabric, aggregate bedding, and underdrain system will not be measured for payment.

(e) **Bridge Spans:** Measurement is for that portion of bridge structure above tops of caps.

(f) **Precast Concrete Girders:** Design quantities include concrete and reinforcement.

601-12 PAYMENT:

(a) **Concrete:** Payment will be made at the contract unit price per cubic yard, which includes formwork, falsework, bracing, pumping, concrete, curing, excavation and backfill.

(b) **Reinforcing Steel:** Payment will be made at the contract unit price per pound.

(c) **Approach Slabs:** Payment will be made at the contract unit price per square yard.

(d) **Bridge Spans:** Payment will be made at the contract unit price per span, which includes bridge deck, sidewalks and railings.

(e) **Precast Concrete Girders:** Payment will be made at the contract unit price per linear foot.

601-13 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
6010100	Class 6A4000 Concrete	Cubic Yard
6010200	Class 7F4000 Concrete	Cubic Yard
6010300	Class 6.5A4200 Concrete	Cubic Yard
6010400	Class 7A4000 Concrete	Cubic Yard
6010500	Reinforcing Steel	Pound
6010600	Bridge Approach Slab	Square Yard
6010700	Bridge Spans	Span
60108--	Type __ Prestressed Concrete Girders	Linear Foot

602-1

SECTION 602

STEEL STRUCTURES

602-1 DESCRIPTION: This work consists of furnishing, fabricating and placing structural metals for structures.

602-2 MATERIALS: Materials shall conform to Section 1011. When the type of structural steel is not specified, steel conforming to ASTM A 709, Grade 36 shall be used.

602-3 GENERAL REQUIREMENTS: Fabrication and erection of structural steel shall conform to the latest AASHTO "Standard Specifications for Highway Bridges".

602-4 SHOP DRAWINGS: The contractor shall submit shop and working drawings in accordance with Subsection 5-7 which show details, dimensions, sizes of material and all information necessary for fabrication of the metal work, including details of match markings.

602-5 INSPECTION: At the Department's option, an authorized representative of the engineer will examine metals to be fabricated before they are worked in the shop and may inspect shop work during its progress.

The contractor shall give the engineer at least 7 days notice before commencement of fabricating operations.

The engineer shall be furnished copies of mill test reports prior to commencing fabrication. The contractor shall furnish assistance for sampling materials. The engineer shall have access to shops where work is being done under these specifications.

No fabricating, machining, cutting, welding, assembling or painting shall be done without the knowledge of the engineer.

Acceptance of material or finished member by the engineer shall not prevent rejection if later found to be defective.

Samples of materials, except castings, shall be cut from stock designated by the engineer or will be selected from items furnished. Castings shall be cast with test coupons.

602-6 WORKMANSHIP AND FINISH: Workmanship and finish shall be in accordance with the best general practice in modern steel fabricating shops.

Before being laid out or worked, rolled material shall be straight. If straightening is necessary, it shall be done by approved methods.

Heat straightening of high strength steels will not be permitted.

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If field straightening is necessary, approved methods shall be used. After straightening, surface of metal shall be inspected for evidence of fracture.

Undercut gusset plates will not be accepted. Sharp corners and edges, and edges that are marred, cut, or roughened in handling or erection shall be slightly rounded.

602-7 RIVET AND BOLT HOLES:

(a) **General:** Holes shall be either punched full size, punched and reamed, or drilled. Finished hole shall be 1/16" larger than nominal rivet diameter.

Holes punched full size shall have burrs and sharp edges removed. Diameter of die shall not exceed that of punch by more than 3/32".

(b) **Rivets:** Holes for rivets shall be subpunched or subdrilled 1/4" less in diameter than finished holes, and shall be reamed to size with parts assembled, with the following exceptions:

1) Holes in material thicker than 7/8" shall not be punched; however, they may be subdrilled to diameter specified for subpunching or may be drilled full size with parts assembled, provided parts are adequately bolted or clamped together.

2) Holes in rolled beams and plate girders, including stiffeners and active fillers at bearing points, may be subpunched 1/8" less in diameter than finished holes, and reamed to size (after assembly) in material not thicker than nominal diameter of rivet less 1/8".

3) Holes in material not more than 7/8" thick, for rivets which do not transfer stress, may be punched full size or subpunched 1/8" less in diameter than finished holes and reamed to size after assembly. This applies to holes for stitch rivets, lateral, longitudinal or sway bracing and their connecting material, lacing, stay plates, diaphragms which do not transfer shear or stress, inactive fillers, and stiffeners not at bearing points. However, holes through assembled material shall not pass through both reamed plies and plies punched full size unless reamed holes have been subpunched, or assembled material is not over 5 plies thick, of which the main material consists of not more than 3 plies.

602-8 REAMING: Reaming shall be done after pieces forming a member are assembled and so firmly bolted together that surfaces are in close contact. Burrs and sharp edges of each reamed hole under both rivet heads shall be removed with a countersinking tool making 1/16" fillets. Pieces shall be taken apart before riveting, if necessary, and shavings removed. If it is necessary to take members apart for shipping or handling, pieces reamed together shall be so marked that they may be reassembled in the same position. Reamed parts shall not be interchanged.

602-9 DRILLED HOLES: Drilled holes shall be 1/16" larger than nominal diameter of rivet. Burrs and sharp edges of hole under both rivet heads shall be removed with a countersinking tool making a 1/16" fillet. Burrs on outside surfaces shall be removed. If members are drilled while assembled, parts shall be held securely together while drilling.

Holes shall be drilled to finish size with metal assembled, or subdrilled and reamed as required for punched and reamed holes.

Holes shall be clean-cut. Holes that must be enlarged to admit rivets shall be reamed.

602-10 ASSEMBLING:

(a) **Shop Work:** At time of assembling and riveting, bolting or welding, steel surfaces in contact for shop or field connection shall be cleaned of rust, loose mill scale, dirt, grease or other foreign material. No paint shall be applied to contact surfaces.

Riveted or bolted trusses, continuous plate girder and I-beam spans, skew portals, skew connections, rigid frames, bents and towers shall be completely assembled in the shop and adjusted to line and camber.

Holes for field connections shall be drilled or reamed while assembled. Holes for other connections shall be drilled or reamed in the shop with connecting parts assembled, or drilled or reamed to a metal template with hardened bushing without assembling.

Long span truss work shall be assembled in lengths of at least 3 abutting panels, members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

Field bolted joints for girders shall be completely assembled, members adjusted for line and camber, and holes for field connections drilled or reamed while assembled.

Field butt joints for welded girders shall be completely assembled with members adjusted for line and camber and prepared to fit for welding.

(b) **Field Work:** Parts shall be accurately assembled and matchmarks followed. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give trusses proper camber. Blocking shall be left in place until tension chord splices are fully bolted and all other truss connections pinned and bolted. Bolts in splices of butt joints of compression members and bolts in railings shall not be driven or torqued until the span has been erected, temporarily bolted, and member is supporting its own weight.

Splices and field connections shall have 1/2 of the holes filled with bolts and erection pins (in approximately equal numbers) before bolting. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.

Fitting-up bolts shall be the same nominal diameter as rivets, and erection pins shall be 1/32" larger.

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Drifting done during assembling shall be only such as to bring parts into position, and not sufficient to enlarge holes or distort metal

Holes that must be enlarged to admit rivets shall be reamed.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be matchmarked, and a diagram showing such marks shall be furnished to the engineer.

602-11 RIVETING: Rivets shall be heated uniformly to a light cherry-red color and driven while hot. Rivets shall be free from slag, scale and other adhering matter. They shall completely fill holes. Heads shall be full size, neatly formed, concentric with shank, free from fins, and in full contact with surface of member.

Loose, burned or otherwise defective rivets shall be replaced. In removing rivets, care shall be taken not to damage adjacent metal. Caulking or recupping will not be permitted.

Rivets shall be driven by direct-acting riveters where possible. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used.

602-12 BOLTED CONNECTIONS: Unfinished or turned bolts shall have hexagonal heads and nuts and shall be of such length that they will extend through nut but not more than 1/4" beyond. Bolts in tension shall have 2 nuts.

Diameter of unfinished bolt shall not be more than 1/32" smaller than diameter of hole.

Threads of turned bolts shall be entirely outside grip. Holes for turned bolts shall be reamed and bolts finished to provide a driving fit. Nut locks or flat washers 1/4" thick shall be furnished.

Connections using high strength bolts shall conform to ASTM A 325.

Holes for bolted connections using high strength bolts shall conform to Subsection 602-7, except as follows: Holes that are required to be subdrilled and reamed may be subdrilled 1/8" less in diameter than that of finished hole, provided offset of any hole in any ply measured from outer ply after hole is finished does not exceed 1/32" and that no more than 20% of the holes shall provide as much offset as 1/32".

602-13 JOINTS AND CONNECTIONS:

(a) **Edge Planing:** Sheared edges of plates more than 5/8" thickness shall be planed to a depth of 1/4".

(b) **Facing of Bearing Surfaces:** Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with each other, with concrete surfaces, or with sheet packing shall be finish-machined flat to within 1/32" tolerance in 12" and to within 1/16" tolerance

602-13

overall. Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with preformed fabric pads, elastomeric and elastic bearing pads, or portland cement grout shall be finish-machined flat to within 1/8" tolerance in 12" and to within 3/16" tolerance overall.

Steel slabs, where not in contact with other metal bearing surfaces, may be heat-straightened in lieu of machining, provided above tolerances are met.

(c) **Abutting Joints:** When specified, abutting joints shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed 1/4".

(d) **End Connection Angles:** Floor beams, stringers and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, finished thickness of angle shall not be less than that specified.

(e) **Web Plates:** In girders having no cover plates and which are not to be encased in concrete, top edge of web plate shall not extend above backs of flange angles and shall be not more than 1/8" below.

(f) **Fit of Stiffeners:** Stiffener angles of girders shall be milled or ground to secure an even bearing against flange angles.

Fillers under stiffener angles shall fit sufficiently tight to exclude water after being painted.

(g) **Pin and Bolted Connections:** Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing on them. In field assembling, pin nuts on pin connections and bolts on bolted connections shall be screwed up tight and the threads, except when high strength bolts are used, burred at face of nuts with a pointed tool.

(h) **Pins and Rollers:** Pins and rollers shall be straight, smooth and free from flaws. Final surface shall be produced by a finishing cut.

Pins and rollers more than 7" diameter shall be forged and annealed.

In pins larger than 9" diameter, forging shall be permitted to cool to a temperature below critical range under suitable conditions, and a hole not less than 2" diameter shall be bored full length along axis of pin before being annealed.

Pin holes in structural members shall be bored to specified diameter, smooth and straight, at right angles with axis of member and parallel with each other. Final surface shall be produced by a finishing cut.

Distance outside-to-inside of holes in compression members shall not vary from that specified more than 1/32". Holes in built up members shall be bored after riveting, bolting or welding is completed.

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Diameter of pin hole shall not exceed that of pin by more than 1/50" for pins 5" or less diameter, or

1/32" for larger pins.

(i) **Screw Threads:** Screw threads shall make close fits in nuts and shall be Unified Standard Series conforming to ANSI B1.1.

602-14 BEARINGS AND ANCHORAGE: When anchor bolts are installed in pipe sleeves, pipes shall be completely filled with grout at time grout pads are constructed or at time bearing assemblies or masonry plates are placed. Swedge bolts installed in holes shall be either sulphured-in or grouted-in.

Bearing assemblies shall be set level. Adjustments in horizontal positions of assemblies shall be made for temperature as directed.

Masonry plates and bearing plates of bearing assemblies shall be set on ground concrete surfaces, preformed fabric pads or grout pads.

Concrete areas to be in contact with grout shall be cleaned of loose or foreign matter and shall be kept saturated with water for 24 hours prior to placing grout. Grout shall contain only sufficient moisture to permit packing and shaping. Grout shall fill anchor bolt sleeves and be tightly packed under masonry or bearing plates. After placing, exposed surfaces of grout pads shall be kept covered with a heavy thickness of burlap saturated with water for at least 3 days.

Immediately before setting bearing assemblies or masonry plates on concrete surfaces, the contractor shall clean surfaces of concrete and metal to be in contact. Bearing assemblies or plates shall then be bedded on a single thickness of sheet lead or preformed fabric bearing pad.

Preformed fabric pads shall be composed of multiple layers of 8 ounces per square yard cotton duck impregnated and bound with high-quality natural rubber or equivalent compressed into resilient pads of uniform thickness. Number of plies shall be such as to produce specified thickness, after compression and vulcanizing. Finished pads shall withstand compression loads perpendicular to plane of laminations of up to 10,000 psi without extrusion or detrimental reduction in thickness.

602-15 WELDING:

602-15.1 Qualification of Procedures, Welders and Welding Operators:

(a) Structural Steel, Steel Pipe and Tubular Members:

(1) **Structural Steel:** Welding procedures, welders and welding operators shall be qualified in accordance with ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code.

(2) **Steel Pipe and Tubular Members:** Welding procedures, welders and welding operators shall be qualified in accordance with ANSI/ AWS D1.1-90 Structural Welding Code-Steel.

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(b) **Reinforcing Steel:** Welding qualification for reinforcing steel shall conform to AWS D1.4-92 Structural Welding Code-Reinforcing Steel.

(c) **Aluminum:** Welding qualification for reinforcing steel shall conform to AWS D 1.2-90 Structural Welding Code-Aluminum.

(d) **Electrodes:**

(1) **Structural Steel:** Electrodes shall be qualified and certified in accordance with ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code.

(2) **Steel Pipe and Tubular Members:** Electrodes shall be qualified and certified in accordance with ANSI/AWS D1.1-90 Structural Welding Code-Steel.

(3) **Aluminum:** Electrodes shall be qualified and certified in accordance with ANSI/AWS D1.2-90, Structural Welding Code-Aluminum.

602-15.2 Welding: Electroslag and electrogas welding processes will not be permitted.

(a) **Structural Steel, Steel Pipe and Tubular Members:**

(1) **Structural Steel:** Welding of structural steel shall conform to ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code.

(2) **Steel Pipe and Tubular Members:** Welding of steel pipe and tubular members shall conform to ANSI/AWS D1.1-90 Structural Welding Code-Steel.

(b) **Reinforcing Steel:** Welding of reinforcing steel shall conform to ANSI/AWS D1.4-92 Structural Welding Code-Reinforcing Steel.

(c) **Aluminum:** Welding of aluminum alloys shall conform to ANSI/AWS D1.2-90 Structural Welding Code-Aluminum.

602-15.3 Nondestructive Testing:

(a) **Structural Steel, Steel Pipe and Tubular Members:**

(1) **Structural Steel:** Non-destructive testing shall conform to ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code except that ends of groove welds on main members shall be tested with the dye penetrant inspection method.

(2) **Steel Pipe and Tubular Members:** Non-destructive testing shall conform to ANSI/AWS D1.1-90 Structural Welding Code-Steel.

(b) **Reinforcing Steel:** Non-destructive testing shall conform to AWS D1.4-92 Structural Welding Code-Reinforcing Steel.

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(c) **Aluminum:** Non-destructive testing shall conform to ANSI/AWS D1.2-90 Structural Welding Code-Aluminum.

Areas contiguous to welding operations shall be preheated to at least 300° F when necessary to

prevent distortion or weld cracking.

Bearing assemblies that are to be machined after welding shall be stress-relieved by heat treatment before machining, in accordance with AWS D1.1.

Portions of members in bearing assemblies or in direct bearing shall be straightened, planed or otherwise corrected after fabrication as necessary to provide full bearing on bearing assemblies or bearing areas on level bearing plates.

Where end of a stiffener plate is shown "tight fit" on plans, the end of plate shall be so fitted that it bears on beam flange with at least point bearing. Clearance between end of plate and flange shall not exceed 1/16".

Erection bolts required for welded splices or welded connections may be left in place and ends of such erection bolts which project beyond nut shall be burned off flush with face of nut.

Where bolt does not project, end of bolt and nut shall be tack welded to prevent loosening of nut. Burning off projecting bolt ends and tack welding shall be performed prior to painting.

602-16 TORCH CUTTING: Torch cutting will not be permitted without approval. Radius of re-entrant flame cut fillets shall be as large as possible, but not less than 3/4". To determine net area of members so cut, 1/8" shall be deducted from flame-cut edges.

Stresses shall not be transmitted through a flame-cut surface.

Torch cuts shall be true to line with a maximum deviation of 1/16". Burned edges shall be finished by grinding.

602-17 BENT PLATES: Cold-bent rolled steel plates shall conform to the following:

(1) They shall be so taken from stock plates that direction of bending will be at right angles to direction of rolling.

(2) Radius of bend, measured to concave face of metal, shall not be less than shown in the following table, in which "T" is plate thickness:

<u>Angle Through Which Plate is Bent</u>	<u>Minimum Radius</u>
61° to 90°	1.0 T
91° to 120°	1.5 T
121° to 150°	2.0T

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(3) Before bending, corners of plate shall be rounded to a radius of 1/16" throughout that portion of plate at which bending is to occur.

If a shorter radius is essential, plates shall be bent hot. Hot-bent plates shall conform to requirement (1) above.

602-18 PAINTING: Except for galvanized items, all structural steel shall be painted with a 3-coat organic zinc primer and topcoat system in accordance with Section 908.

602-19 MEASUREMENT:

(a) **Weight Basis:** Structural steel will be measured by the weight of metal in pounds remaining in completed structures. The weight will be computed on the basis of theoretical net weights from approved shop drawings. No allowance will be made for shear connectors, rivets, bolts, nuts, washers or welds and no deductions will be made for rivet holes, bolt holes, beam copings, cut flanges or edge preparation for welding. Deduction will be made for pin holes. Plates shall be estimated from sizes billed and deductions made for cut corners.

No measurement will be made for temporary work or for additional weight in members provided for erection purposes.

No allowance will be made for shop or field paints, galvanizing or other coatings.

No allowance will be made for overrun on plates or rolled sections.

ASTM A 709, Grade 36 steel shall include all metal classified as such in the plans and specifications and such items as pins, rollers, metal railings, steel plates and shapes for expansion joints, ladders, wrought iron sheets, checkered floor plates, bronze castings and plates, and steel and iron castings.

ASTM A 709, Grade 50, 50W, 70W, and 100 steel shall include all steel classified as such in the plans or specifications.

Metal weights will be computed on the following basis:

<u>Metal</u>	<u>Wt (lb/cu ft)</u>
Aluminum, cast or wrought	173
Bronze, cast.....	536
Copper-alloy	536
Copper, sheet	558
Iron, cast.....	445
Iron, malleable	470
Iron, wrought	487
Lead, sheet	707
Steel, rolled, cast, copper bearing, silicon, nickel and stainless.....	490
Zinc	450

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(b) **Lump Sum Basis:** When payment is specified to be made by the lump sum, no weight measurement of metal will be made. Any estimate of the weight of structural metalwork shown on the plans is approximate and no guarantee is made that it is the correct weight of each grade of metal to be furnished. It is the contractor's responsibility to determine the correct weight of each grade of metal furnished. Shop bills will not be required.

602-20 PAYMENT:

(a) **Weight Basis:** Payment for the various classifications of structural metals will be made at the respective contract unit prices per pound.

(b) **Lump Sum Basis:** Payment will be made at the contract lump sum price, which includes furnishing, fabricating, erecting, painting, galvanizing or other coating of all necessary materials; furnishing all required labor, plants, equipment, tools, staging, falsework, forms, welding, bolts and other hardware; and the performance of all work necessary to complete the item.

When changes in the work are ordered, which vary the weight of steel to be furnished, the lump sum payment will be adjusted as follows:

The value per pound of the increase or decrease in the weight of structural steel involved in the change will be determined by dividing the contract lump sum amount by the estimated weight shown on the plans. The adjusted contract lump sum payment will be the contract lump sum amount plus or minus the value of the steel involved in the change, and no additional compensation will be made on account of said change.

If a change in the grade of steel to be furnished is ordered, resulting in additional cost to the contractor, compensation will be made in accordance with Subsection 10-4.

602-21 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
6020100	Steel (ASTM A 709, Grade 36)	Pound
6020200	Steel (ASTM A 709, Grade 50)	Pound
6020300	Steel (ASTM A 709, Grade 50W)	Pound
6020400	Steel (ASTM A 709, Grade 70W)	Pound
6020500	Steel (ASTM A 709, Grade 100)	Pound
6020600	Structural Steel	Lump Sum

SECTION 603

TIMBER STRUCTURES

603-1 DESCRIPTION: This work consists of furnishing and constructing timber structures.

603-2 MATERIALS: Materials shall conform to the following Subsections:

Castings	1011-4, 1011-5
Structural Timber	1013-1
Preservatives	1013-3
Treatment	1013-4
Hardware (Galvanized)	1011-11

Timber may be either pine or fir.

603-3 MATERIAL STORAGE: Timber stored on the site shall be kept in orderly stacks. Untreated material shall be open stacked on supports at least 12" above ground, and shall be so stacked as to permit circulation of air between courses. When directed, protection from weather by suitable covering will be required.

603-4 TREATED TIMBER:

(a) **Workmanship:** Nails and spikes shall be driven with just sufficient force to set heads flush with the surface of the wood. Deep hammer marks in surfaces shall be considered evidence of poor workmanship and cause for removal of workman causing them.

(b) **Surfacing:** Timber, except bulkhead planks and sway bracing, shall be S4S.

(c) **Handling:** Treated timber shall be handled with rope slings, without dropping or breaking of outer fibers, bruising, or penetrating surface with tools.

(d) **Framing and Boring:** Cutting, framing and boring of treated timber shall be done before treatment insofar as practical.

(e) **Cuts and Abrasions:** Cuts and abrasions in creosoted piles or timbers shall given 2 coats of preservative and coated with hot roofing pitch.

Cuts and abrasions in timbers treated with other preservatives shall be repaired with the same preservative.

(f) **Bolt Holes:** Holes bored in treated material shall be filled with preservative. Unused bore holes and spike holes shall be poured full of preservative and plugged with tight-fitting treated plugs.

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(g) **Temporary Attachment:** When forms or temporary braces are attached to treated timber with nails or spikes, holes shall be filled by driving galvanized nails or spikes flush with surface or plugged as required for bolt holes.

603-5 TREATED TIMBER PILE HEADS:

(a) **Foundation Piles:** After piles are cut off, cut area shall be given 2 coats of preservative and a heavy coat of coal-tar pitch.

(b) **Bent Piles:** Pile heads to be encased in concrete will not require treatment. After cutoff of piles not to be encased in concrete, cut area shall be given 2 coats of preservative, then covered with 2 layers of 20" x 20" heavy canvas saturated with hot asphalt, and a 24" x 24" 28-gage galvanized metal cover bent down approximately 45° over pile.

603-6 HOLES FOR BOLTS, DOWELS, RODS AND LAG SCREWS: Holes for drift-bolts and dowels shall be bored 1/16" smaller than bolt or dowel. For square drift bolts or dowels, diameter of bored hole shall be equal to least dimension of bolt or dowel.

Holes for machine bolts shall be bored the same diameter as bolt.

Holes for rods shall be bored 1/16" larger than rod.

Holes for lag screws shall be bored not larger than body of screw at base of thread.

603-7 BOLTS AND WASHERS: A washer of size and type specified shall be used under bolt heads and nut which would otherwise come in contact with wood. Stacked washers will not be permitted. Bolts shall not project more than 1" beyond nut. Long bolts shall be saw-cut or clipped, ground smooth and coating repaired.

603-8 FRAMING: Timber shall be cut and framed in such manner that joints will have even bearing over contact surfaces. No shimming will be permitted in making joints nor will open joints be accepted. Mating pieces shall be tightly bound or clamped in position prior to drilling bolt holes.

603-9 CAPS: Timber caps shall be placed, with ends aligned, in a manner to secure uniform bearing on piles. Caps shall be secured by drift-bolts at least 3/4" diameter extending at least 9" into piles.

Drift-bolts shall be in center of pile.

603-10 BRACING: Bracing shall be fastened to piles at each end and each intersection by bolts at least 5/8" diameter. Bracing shall be of such length to provide at least 8" between outside bolt and end of brace. Piles shall not be cut to accommodate bracing; however, treated filler blocks shall be used to fill spaces between piles and bracing.

603-11 STRINGERS: Stringers shall be sized at bearings and placed in position so that knots near edges will be in top portions of stringers.

603-12

Outside stringers shall have butt joints and interior stringers shall be lapped to provide bearing over full width of floor beam or cap at each end. When stringers are 2 panels in length, joints shall be staggered.

Cross-bridging between stringers shall be toe-nailed with at least 2 nails in each end. Cross-bridging members shall have full bearing at each end against sides of stringers. Cross-bridging shall be placed at 1/3 points of each span.

603-12 PLANK DECKING: Planks for single plank decks shall be laid heart side down, with 1/4" openings between them. Each plank shall be securely spiked to each joist. Planks shall be graded as to thickness and so laid that no adjacent planks vary in thickness by more than 1/16".

Top course of 2-ply decking shall be laid diagonal to roadway centerline and each piece securely fastened to lower course. Joints shall be staggered at least 3 feet.

603-13 WHEEL GUARDS AND RAILING: Wheel guards and railing shall be erected true to line and grade. Wheel guards shall be laid in sections at least 12 feet long.

603-14 MEASUREMENT: Quantities of timber for payment will be the design quantities adjusted as required due to plan errors or plan changes. The design quantities are based on the number of thousand board feet of timber in the completed work. Hardware will not be measured for payment.

603-15 PAYMENT: Payment for timber will be made at the contract unit price per thousand board feet (MFBM).

603-16 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
6030100	Treated Timber	MFBM

604-1

SECTION 604

SHEET PILES

604-1 DESCRIPTION: This work consists of furnishing and driving sheet piling.

604-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Metal Sheet Piles	1011-7
Concrete Sheet Piles	1009
Timber and Preservatives	1013
Hardware	1011-11
Coal Tar Epoxy-Polyamide Paint	1012-3

Timber piles shall be either pine or fir and shall be provided with tongues and grooves either cut from solid material or made by building up piles with 3 planks fastened together. Piles shall be drift-sharpened at lower ends to wedge adjacent piles tightly together during driving. Hardware shall be galvanized.

604-3 DRIVING SHEET PILES: Piles shall be driven in such increments of penetration as necessary to prevent distortion, twisting out of position or pulling apart at interlocks. To facilitate closure, piles can be set up for a complete length of wall before initial driving, then progressively driven in short increments of penetration.

Piles damaged during driving or out of proper position or below cut-off shall be withdrawn and replaced with a new pile at no direct pay.

The contractor may use water jetting systems to erode material adjacent to pile to facilitate driving; however, use of jets will not be permitted where stability of embankments or other improvements would be endangered.

Jetting may be done ahead of or simultaneously with driving operations. If jets and hammer are used simultaneously, jets shall be withdrawn and final penetration of piles obtained by driving with hammer alone for at least the last foot of penetration.

604-4 CUT-OFF OF PILES: Tops of piling shall be cut off or driven down to a straight line at required elevation.

If heads of piles are damaged below cut-off, damaged piling shall be repaired or removed and replaced at no direct pay.

Tops of treated timber piles after cut-off shall be treated in accordance with Subsection 603-5 (b), except that metal coverings shall be bent down at least 3" on each side and nailed to vertical surface of piles with large-headed galvanized roofing nails.

604-5 PAINTING: Before driving, surfaces of permanent steel piling shall be cleaned and painted with a 2-coat coal tar epoxy-polyamide paint system in accordance with Section 908.

604-6 MEASUREMENT: Quantities of sheet pile wall for payment will be the design wall area as specified on the plans, adjusted as required due to plan errors or plan changes.

604-7 PAYMENT: Payment for sheet pile wall will be made at the contract unit prices.

604-8 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
6040100	Treated Timber Sheet Pile Wall	Square Foot
6040200	Concrete Sheet Pile Wall	Square Foot
6040300	Steel Sheet Pile Wall	Square Foot
6040400	Aluminum Sheet Pile Wall	Square Foot

605-1

SECTION 605

BEARING PILES

605-1 DESCRIPTION: This work consists of furnishing, driving and test loading piles.

605-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Precast Concrete Piles	1009
Steel Bearing Piles	1011-6
Steel Pipe Piles	1011-8
Timber Piles	1013-2
Portland Cement Concrete	1005
Reinforcing Steel	1006

605-3 ORDER LISTS: The contractor shall furnish piles in accordance with an itemized list furnished by the engineer showing number, size, length and location of permanent piles. No permanent piles shall be driven prior to receipt of this order list. When test piles are driven to determine pile lengths, the order list will not be furnished the contractor until loading is completed and order lengths approved. Pile lengths given in the order list will be based on lengths which are assumed to remain in the completed structure. The contractor shall, at no direct pay, increase the lengths given to provide such additional length as necessary to suit the contractor's method of operation. The order lengths may be revised by the engineer when driving conditions deviate from test pile results.

605-4 PREPARATION FOR DRIVING: If, in the opinion of the engineer, pile driving operations may cause damage to recently placed concrete, the contractor shall alter operations to prevent such damage.

605-4.1 Excavation and Embankment: All excavation and embankment shall be completed before driving affected piles.

605-4.2 Transporting Concrete Piles: Precast concrete piles shall be transported with supports at each of the pick-up points shown on the plans.

605-4.3 Supporting Holes: Piles may be set in supporting holes with a depth not over 20% of required pile penetration. If additional support is required, templates or falsework above ground shall be furnished. After piles are driven, holes shall be backfilled to finished ground or base of footing with granular material.

605-5 DRIVING EQUIPMENT:

605-5.1 Steam and Air Hammers: Plant and equipment for steam and air hammers shall have sufficient capacity to maintain at the hammer, under working conditions, the volume and pressure specified by the manufacturer. Plant and equipment shall have accurate pressure gages which are easily accessible for viewing by the engineer.

605-5.2 Diesel Hammers:

(a) **Single Acting:** Single acting (open-end) diesel hammers shall be equipped with a device to permit the engineer to determine height of fall of ram. Before driving, the contractor shall provide the engineer with a chart from the hammer manufacturer equating stroke and blows per minute for hammer to be used.

(b) **Double Acting:** Double acting (closed-end) diesel hammers shall have a bounce chamber pressure gage mounted near ground level. Before driving, the contractor shall provide the engineer a chart, calibrated to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for hammer to be used.

605-5.3 Collars: If necessary, timber piles shall be fitted with metal collars or bands, at no direct pay, to protect against brooming or splitting.

605-5.4 Hammers for Timber Piles: Drop hammers for driving timber piles shall weigh at least 2,000 pounds. Fall shall be so regulated as to avoid damaging piles and shall not exceed 10 feet. When timber piles are driven with steam, air or diesel hammers, energy developed by hammer shall be 7,200 to 20,000 foot-pounds per blow.

605-5.5 Hammers for Concrete Piles: Precast concrete piles or shells for cast-in-place concrete piles shall be driven with a hammer which develops at each full stroke of the piston at least 1 foot-pound of energy for each pound of weight driven; however, hammer energy shall be 15,000 to 60,000 foot-pounds.

605-5.6 Hammers for Steel Piles: Steel piles shall be driven with a hammer which develops an energy at each full stroke of the piston of at least 1 foot-pound for each pound of weight driven, the minimum being 15,000 foot-pounds.

605-5.7 Hammer Cushion: All impact pile driving equipment except gravity hammers shall be equipped with hammer cushion material to prevent damage to pile. A striker plate as recommended by hammer manufacturer shall be placed on hammer cushion. The contractor shall replace cushion when damaged or substantially reduced in thickness.

605-6 DRIVING PILES:

605-6.1 Driving Caps: When nature of driving requires protection for heads of concrete and timber piles, pile driving heads shall be cushioned by a cap. Cap shall have a suitable cushion next to pile head. When area of head of a timber pile is greater than that of face of hammer, a suitable cap shall be provided to distribute blow of hammer throughout cross section of pile.

605-6.2 Pilot Holes and Water Jetting: If required pile penetration is not obtained by use of a hammer complying with the above requirements, the contractor shall use pilot holes or water jets or both with hammer.

605-6

Pilot holes will be required when piles are driven in embankments and when borings indicate impenetrable material above minimum tip elevation. Maximum diameter of pilot holes will be the pile diagonal for square piles, and diameter of pile tip of round piles. Depth of pilot holes in embankment shall be equal to embankment height.

When water jets are required, the number and size of jets and the volume and pressure of water at nozzles shall be sufficient to erode material adjacent to pile. Before desired penetration is reached, jets shall be withdrawn and piles shall be driven with hammer to final penetration. Jetting will not be permitted within 5 feet of pile tip elevation.

605-6.3 Accuracy of Driving: In pile bents, the centroid of a pile at cut-off elevation shall not vary from plan location by more than 3" measured perpendicular to bent, nor more than 6" measured along centerline of bent. Piles shall be driven with a variation of not more than 1/4" per foot from vertical or from specified batter. For foundation piling, the centroid of a pile at cutoff shall be within a 12" diameter circle having plan location as its center.

605-6.4 Interrupted Driving: When driving is interrupted before pile reaches final penetration, the record for resistance shall not be taken until after at least 12" of penetration have been obtained after driving is resumed.

605-6.5 Extent of Driving: Driving shall be continued until plan cut-off is reached. If desired resistance to driving is not obtained at plan cut-off, the engineer may order that pile be test loaded to determine its capacity or that driving be continued until satisfactory driving resistance is attained, in which case the additional pile length required shall be supplied by splicing.

If desired driving resistance is obtained before reaching plan cut-off and the engineer determines that continued driving could damage the pile, the engineer may order that driving be stopped when at least 2/3 of required penetration has been achieved.

605-6.6 Splicing:

(a) **Precast Concrete Piles:** Precast concrete piles shall be furnished and driven in full lengths.

(b) **Cast-in-Place Concrete Piles:** Shells for cast-in-place concrete piles shall be spliced by welding in accordance with Subsection 602-15, except that pre-qualification of welders will not be required.

(c) **Steel Bearing Piles:** Steel bearing piles shall be spliced with full penetration welds in accordance with Subsection 602-15.

(d) **Timber Piles:** Splicing of timber piles may be made only with written permission and by an approved method.

605-7

605-7 CAST-IN-PLACE CONCRETE PILES: Cast-in-place concrete piles shall be steel encased. After shells are driven and reinforcing steel is placed, shells shall be filled with concrete. The contractor shall provide suitable light for inspection of each shell after it has been driven. Shell shall be cleaned of debris and pumped dry before placing concrete.

Shell shall be filled with Class 6A4000 concrete. Reinforcing steel shall be securely fastened together to form a cage. Care shall be taken to hold reinforcement in position during filling of piles. Concrete blocks or suitable devices may be used to prevent displacement of reinforcement cage. Piles shall be filled with concrete to cut-off elevation and concrete vibrated from lower end of reinforcing cage to top of pile. Driving of additional piles within 10 feet of completed pile will not be permitted until concrete has been allowed to set for at least 36 hours.

Shells for cast-in-place concrete piles shall be of sufficient thickness and strength to hold their original form and show no distortion after driving. It shall be the contractor's responsibility to determine wall thickness of shell required.

605-8 DEFECTIVE PILES: Any pile found to be unacceptable due to internal defects, by improper driving, driven out of proper location, or driven below required elevation shall be corrected at no direct pay by one of the following methods approved by the engineer:

1. Pile shall be withdrawn and replaced by a new and, if necessary, a longer pile.
2. A second pile shall be driven adjacent to defective pile.
3. Pile shall be spliced or footing extended to embed pile.
4. Cap or footing shall be redesigned.

605-9 BEARING VALUE: Bearing value of piles shall be determined from the following formulas:

Drop hammer:

$$P = \frac{2WL}{S + 1}$$

Single acting steam, air or diesel hammer:

$$P = \frac{2WL}{S + 0.1}$$

Double acting steam or air hammer:

$$P = \frac{2L(W + ap)}{s + 0.1}$$

605-10

P = safe bearing load of pile in pounds.

W	=	weight of hammer in pounds.
L	=	length of stroke or height of fall of hammer in feet.
s	=	penetration of pile per blow in inches (average for last 10 blows).
a	=	effective area of piston in square inches.
p	=	mean effective pressure in psi.

If water jets are used, bearing capacity will be determined from results obtained by driving after jets have been withdrawn.

605-10 TEST PILES:

(a) Test piles shall be driven using the same type hammer, energy and procedures as intended for permanent piles.

(b) When test piles are driven to determine length of foundation piles or when test pile is being driven on a stream bank where the most critical pile is in the middle of stream, test pile shall model subsurface conditions of permanent piles as directed. The contractor shall excavate test pile location to bottom of footing or stream and keep this excavation open during driving and loading of test piles. In lieu of the above, the contractor will be permitted to drive test pile within a casing. Casing shall extend to bottom of footing, the elevation shown on the plans or stream bottom. The contractor shall, at no direct pay, provide any bracing or strengthening of test pile required during loading or driving.

(c) Cast-in-place concrete test piles shall be filled with concrete and concrete allowed to set for at least 48 hours before first increment of test load is applied.

(d) If a permanent pile is used as a test pile and fails under test load, and redriving is required, steel bearing piles shall be extended by splicing (if necessary) and redriven to designated depth; other types of piles shall be removed and a new test pile driven to designated depth at an approved location.

(e) Test piles not to be used as permanent piles shall be removed to at least 2 feet below natural ground or stream bed and disposed of as directed.

(f) Permanent concrete piles shall not be used as anchor piles.

605-11 LOADING PILES:

(a) **General:** Test loading shall consist of applying a static load on a platform supported by the pile. Platform shall be equipped to measure test load and pile settlement under each increment of load. In lieu thereof, hydraulic jacks with yokes and pressure gages may be used.

605-12

(b) **Loading Test Piles:** A test pile will be loaded when bearing capacity of pile is less

than 2 times design load as determined in accordance with Subsection 605-9 or when directed. Test piles shall remain undisturbed for at least 14 days after driving to required penetration before loading. Load shall be applied in increments of 10% to 15% of design load, as directed. Each load increment shall be held for 5 minutes. Gross settlement readings, loads and other data shall be recorded by the engineer before and after application of each load increment.

Test piles shall be loaded to failure. Test pile will be considered to have failed when continuous jacking is required to maintain load and pile is being driven into ground. Jacking shall cease when gross settlement has reached 10% of average pile diameter or diagonal dimension. Gross settlement readings, loads and other data shall be recorded immediately after jacking has stopped and again after 5 minutes. Final rebound readings shall be recorded after test pile has remained at zero load for 1 hour.

Safe allowable load of a pile so tested shall be 1/2 the maximum load reached before failure occurs.

(c) **Loading Permanent Piles:** When driving resistance of a permanent pile is less than that of test pile and will not correlate with test pile data, the engineer may direct the contractor to load a permanent pile at driven tip elevation. When loading a permanent pile is directed, loading shall be conducted as described above in Heading (b), except pile shall be loaded to failure or until 2 times design load is reached.

605-12 CUT-OFFS:

(a) **Precast Concrete, Cast-in-Place Concrete and Steel Bearing Piles:** Cut-offs for shall be made perpendicular pile axis.

(b) Timber Piles:

(1) Tops of timber piling which support concrete footings or caps shall be sawed off perpendicular to their axis.

(2) Piles which support timber caps shall be sawed to a horizontal plane, or to slope specified, in such manner as to fit cap.

(3) Shimming on tops of piles will not be permitted.

(4) Treatment of pile heads shall conform to Subsection 603-5.

605-13 MEASUREMENT:

(a) **Pilings:** Piling will be measured by the linear foot below pile cut-off elevation.

605-14

(b) **Cut-offs:** Cut-offs made as directed will be measured by the linear foot. Measurement will not be made for cut-off of a pile unless the length of such cut-off is in excess of 1 foot, nor will payment for cut-offs be made where they have been necessitated by crushing, brooming, splitting or

other damage. No measurement will be made for required cut-offs of steel bearing piles and cast-in-place concrete pile shells; such cut-offs will remain the property of the contractor.

(c) **Splices:**

(1) **Timber Piles:** Measurement of splices on timber piles will be by the linear foot. The total number of linear feet of piling driven will be determined by adding 10 feet to net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(2) **Steel Bearing Piles:** Measurement of splices on steel bearing piles will be by the linear foot. The total number of linear feet of piling driven will be determined by adding 2 feet to net length of piling for each splice in place in the finished structure. No measurement will be made for splices except those made as directed.

(3) **Cast-in-Place Concrete Piles:** Splices for cast-in-place concrete piles will be measured as specified for steel bearing piles in Heading (2) above.

(d) **Test Piles:** The number of test piles to be paid for will be the number of piles of each type furnished and driven. Cut-offs of test piles will not be included in any pay footage.

Test piles pulled and reused as permanent piles will be measured as provided under Heading (a).

(e) **Loading Test Piles:** The number of load and reload tests to be paid for will be the number of tests ordered and completed.

(f) **Loading Permanent Piles:** The number of load tests to be paid for will be the number of load tests made as directed.

605-14 PAYMENT:

(a) **Piling:** Payment for piling will be made at the contract unit price per linear foot, which includes bolting, wrapping or fastening timber fender piles, driving batter piles, concrete and reinforcing steel, and jetting or pilot holes.

(b) **Cut-offs:** Payment for cut-offs will be made at the contract unit price per linear foot for the type and size of pile.

(c) **Splices:** Payment for splices will be made at the contract unit price per linear foot for the type of pile spliced.

605-15

(d) **Test Piles:** Payment for test piles will be made at the contract unit price per each.

(e) **Loading Test Piles:** Payment for loading and reloading test piles will be made at the

contract unit price per each.

(f) **Loading Permanent Piles:** Payment for loading permanent piles will be made at the contract unit price per each.

605-15 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
60501--	___" Precast Concrete Piles	Linear Foot
6050200	Treated Timber Piles	Linear Foot
60503--	___" Steel Bearing Piles	Linear Foot
60504--	___" Cast-In-Place Concrete Piles	Linear Foot
60505--	___" Precast Concrete Test Piles	Each
6050600	Timber Test Piles	Each
60507--	___" Steel Bearing Test Piles	Each
60508--	___" Cast-In-Place Concrete Test Piles	Each
6050900	Loading Test Piles	Each
6051000	Loading Permanent Piles	Each

SECTION 606

DRILLED SHAFT FOUNDATIONS

606-1 DESCRIPTION: This work consists of furnishing and constructing reinforced concrete foundation shafts.

606-2 MATERIALS: Materials shall conform to the following Sections and Subsection. Concrete shall be Class 7A4400 with a water reducing, set retarding admixture.

Portland Cement Concrete	1005
Backfill Sand	1001-10
Reinforcing Steel	1006

606-3 DRILLING: The contractor shall perform drilling required for shafts and bell footings through whatever materials are encountered. When satisfactory material is not encountered at plan tip elevation, bottom of shaft will be adjusted, or foundation altered, as directed. Shafts shall be bored to a tolerance of 1/4" per foot from vertical or from specified batter. For shafts supporting single columns, the center shall lie within 3" of plan location. For foundation shafts, the center shall be within a 12" diameter circle having plan location as its center. Bells, when required, shall be excavated to form a bearing area of specified size and shape.

Shafts and bells shall be excavated by mechanical methods.

Casings will be required for shaft excavations when necessary to prevent caving of material or to shut off seepage water. Casings shall be of sufficient strength to withstand handling stresses and pressure of concrete and surrounding earth or backfill materials, and shall be watertight.

Diameter of casing shall not be less than required to obtain specified shaft diameter for full length. Casing shall be smooth, clean and free of hardened concrete. A vibratory hammer or vibratory extractor will be allowed for placement and removal of casing.

If elevation of top of shaft is below ground, an oversize surface casing from ground elevation to a point below top of shaft shall be used to prevent caving of materials into fresh concrete. Surface casing shall not remain in place unless permitted. It shall not be extracted until completion of concrete placement.

Excavation for footing bells or shafts beyond plan dimensions, where casings are not required, shall be backfilled with concrete at no direct pay. Where casings are used, the contractor will be permitted to backfill around upper portion of casing with sand. Where a double casing is required, area between casings shall be filled with concrete.

Casing removal shall not be started until shaft concrete placement is completed. Movement of casing for short pulls of a few inches or rotating casing to insure breaking of bond of concrete to casing will be permitted. When conditions warrant, casing may be pulled in stages.

A sufficient head of concrete shall be maintained above bottom of casing to overcome hydrostatic pressure. At least 2 points of connection to casing will be required for removal. Extraction of casing shall be at a slow, uniform rate and pull shall be concentric with centerline of shaft. Casings shall not remain in place without approval.

Material excavated from shafts and bells, and not used elsewhere on the project, shall be disposed of in accordance with Section 202.

When concrete is placed, drilled hole and base shall be free from accumulated seepage water, and loose material shall be removed from base. The contractor shall provide suitable access and lighting for the engineer to inspect completed drilled hole and base and check dimensions and alignment of drilled shafts and bell (when underreaming is required). Concrete shall not be placed underwater without approval.

Provisions shall be made for pumping fresh air to workmen and inspectors in drilled hole. Any required lighting shall be by electric lights. Use of internal combustion engines placed in drilled hole for pumping or drilling will not be permitted.

When directed, the contractor shall make soundings or take borings to determine character of supporting materials at no direct pay. Depth of such soundings or borings will not be required to extend more than 5 feet below tip elevation.

Bridge end embankments shall be completed prior to drilling for end bent shafts.

606-4 REINFORCING STEEL: Reinforcing steel cage shall be assembled and placed in shaft as a unit. Reinforcing steel cage may be fabricated in 2 sections. Upper section shall be lap spliced to lower section while lower section is partially lowered into shaft hole. Cage shall then be lowered into final position as a unit. Cage shall not be placed until immediately before concrete operations are started. Cage shall be supported from top to prevent slumping downward during concrete placement.

Minimum length of steel required for lap with column steel shall be maintained. Dowel bars may be used if proper lap length is provided both into shaft and column. Dowel bars in top of shaft which are not tied together with a cage may be inserted immediately after concrete placement.

In uncased shafts, side spacer blocks of concrete or steel shall be used at intervals along shaft to insure concentric spacing. In cased shafts, concrete spacer blocks shall not be used; metal chair-type spacers shall be placed vertically at intervals around steel cage to insure concentric spacing inside casing.

606-5 CONCRETE: Concrete shall be placed in accordance with Section 601 and requirements herein.

606-6

Concrete placing shall be continuous from bottom of shaft or footing bell to top of shaft or to construction joint indicated on the plans. Time intervals will be allowed for pulling casings, placing forms and other necessary operations.

Concrete shall be placed as soon as possible after excavation is completed and reinforcing steel placed, and shall be of such workability that vibrating or rodding will not be required. Casings shall extend sufficiently above grade of finished shaft to provide for excess concrete to be placed for anticipated slump due to casing removal. Concrete shall be placed through a tremie to bottom of excavation. Tremie shall be made in sections to permit its being raised as placement progresses.

When a pump is used, discharge tube shall be submerged in previously placed concrete. Additional concrete shall be placed to assure removal of any contaminated concrete at top of shaft.

When concrete placement is interrupted due to withdrawal of submerged end of tremie, tremie shall be removed, resealed at bottom, forced into concrete already placed and recharged prior to progressing further.

When drilled shaft is continued by means of a column, the contractor shall make provisions for holding column form at top of drilled shaft by means of inserts or by forming and pouring a stub the size of column.

606-6 TEST HOLES AND BELLS: When required, test holes shall be drilled to establish elevations for bells and determine soil conditions and ground water elevations. When required, test holes shall be belled to determine if soil can be satisfactorily underreamed.

606-7 MEASUREMENT:

(a) **Drilled Shafts:** Drilled shafts will be measured by the linear foot. At interior bridge bents and piers, shafts will be measured from a point 6" below ground elevation at center of shaft after clearing operations are completed. At roadway grade separations and railroad underpasses, ground elevation will be completed roadway section under structure. At stream crossings and railroad overpasses, ground elevation will be elevation existing at time drilling begins. At abutment bents, length of shaft will be measured from top of shaft elevation shown on the plans.

(b) **Bell Footings:** Bell footings will be measured by the cubic yard of authorized volume outside dimensions of drilled shaft.

(c) **Test Holes and Test Bells:** Test holes and test bells will be measured from elevation of ground at time drilling begins by the linear foot of test hole drilled and underreamed.

606-8

606-8 PAYMENT:

(a) **Drilled Shafts:** Payment for drilled shafts will be made at the contract unit price per linear foot, subject to the following limitations for authorized overruns. Payment will include required excavation, pumping, furnishing and placing casings, furnishing and placing concrete and reinforcement, removing casings, casings left in place, and disposal of excess excavated material. No payment will be made for concrete required to fill oversize casings or excavation.

1. Payment for shaft lengths up to and including 5 feet in excess of plan length will be made at the contract unit price per linear foot.

2. Payment for that portion of shaft length greater than 5 feet more than plan length will be made at 115% of the contract unit price per linear foot.

3. Payment for additional reinforcement required, including splices, for the extra shaft length will be made at the contract unit price per pound for reinforcing steel.

(b) **Bell Footings:** Payment for bell footings will be made at the contract unit price per cubic yard.

(c) **Test Holes and Test Bells:** Payment for test holes will be made at the contract unit price per linear foot. Payment of test bells will be made at the contract unit price per each.

606-9 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
60601--	___" Drilled Shaft	Linear Foot
6060200	Bell Footing	Cubic Yard
60603--	___" Test Hole	Linear Foot
60604--	___" Test Bell	Each

PART VII
DRAINAGE WORK

SECTION	TITLE	PAGE
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SECTION 701

CULVERTS AND STORM DRAINS

701-1 DESCRIPTION: This work consists of furnishing and installing culverts and storm drains.

When an item for "Storm Drain Pipe" is included in the contract, the contractor has the option of furnishing either reinforced concrete pipe or plastic pipe.

701-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Bedding Material	1001-9
Reinforced Concrete Pipe	1015-1
Reinforced Concrete Pipe Arch	1015-2
Plastic Pipe	1015-4
Bituminous Coated Corrugated Steel Pipe and Pipe Arch	1015-3
Polymer Coated Corrugated Steel Pipe and Pipe Arch	1015-3
Portland Cement Concrete	1005
Reinforcing Steel	1006-1
Precast Concrete Box Culvert Units	1017-1
Geotextile Fabric	1022-8
Backfill Sand	1001-10
Bedding Material	1001-9

701-3 TRENCHING AND BEDDING: Trenches shall be excavated to specified width; if not specified, trenches shall be excavated to a width of at least 18" on each side of conduit.

Trenches shall be excavated to the depth required accommodate placement of bedding material. Bedding material shall be placed and mechanically compacted in lifts not more than 6" thick (compacted) to at least 95% of maximum density determined by AASHTO T 99. If foundation is stable, bedding material shall be placed as follows:

(a) **Concrete Pipe or Box Culvert:** Bedding material shall be placed in trench bottom.

(b) **Plastic Pipe or Steel Pipe:**

(1) **Pipe Under or Within 5 Feet of Pavement:** Bedding material shall be placed up to 12" above pipe.

(2) **Pipe More Than 5 Feet From Pavement:** Bedding material shall be placed up to the top of the pipe.

If unstable material is encountered at trench bottom, unstable material shall be excavated as directed and replaced with bedding material. Payment for additional excavation and bedding below specified bedding layer under pipe will be made as extra work in accordance with Subsection 10-4.

Sides of trenches deeper than 5 feet shall be sloped, benched, shielded or shored in accordance with OSHA requirements. Unless otherwise permitted, all trench sheeting shall be removed.

701-4 LAYING CONDUIT: Laying shall begin at downstream end of line. Conduit shall be in contact with foundation throughout its length. Bell or groove ends of conduit and outside circumferential laps of corrugated steel pipe shall be placed facing upstream. Riveted seam corrugated steel pipe shall be placed with longitudinal laps at sides. Corrugated steel pipe with lifting lugs shall be handled only by the lugs, and those without lugs shall be handled only by rope slings.

When existing pipe is to be relaid, pipe shall be removed by methods that will not damage pipe and relaid as specified for new pipe.

701-5 JOINTING CONDUIT:

(a) **General:** Joints shall be capable of withstanding at least 10 psi hydrostatic pressure without leakage.

Joints without coupling bands shall be wrapped with geotextile fabric for at least 12" on each side of joints for conduits up to and including 36", and at least 18" on each side of joints for larger conduits.

Joints with coupling bands shall be wrapped with geotextile fabric for at least 12" on each side of bands for pipe sizes up to and including 36", and 18" on each side of bands for larger pipe sizes.

Ends of fabric shall be lapped at least 10", and ends and edges secured.

(b) **Concrete Pipe and Precast Box Culverts:** For conduits less than 48", sections shall be joined by methods which fully seat joints without damaging conduit. For larger conduits, sections shall be joined with a mechanical puller.

(1) **Round Pipe:** Gaskets shall be rubber O-rings. Just prior to jointing, O-ring and gasket seat shall be cleaned of dirt and other

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foreign matter and coated with a flax soap lubricant. Pipe section shall then be joined tightly to previously laid pipe.

(2) **Pipe Arch and Precast Box Culverts:** Conduit ends shall be cleaned of dirt and other foreign matter and shall be dry. A uniform and adequate thickness of plastic gasket material shall be placed on the entire circumference of gasket seat. In temperatures below 60°F, gasket material shall be heated prior to placement. Conduit section shall then be joined tightly to previously laid conduit.

(c) **Corrugated Steel Pipe:** Pipe sections shall be joined by connecting bands centered over joint. Flexible plastic gasket material shall be placed on entire circumference of pipe under band in 2 corrugations on each side of joint. Bands shall be at least 12" wide for pipe sizes less than 36", and at least 21" for larger pipe sizes.

(1) **Round Pipe:** Coupling bands shall be secured by 2 rods and lugs on each side of joint.

(2) **Arch Pipe:** For pipe sizes less than 36" round equivalent, 1-piece bands may be used; for larger pipe sizes, 2-piece bands shall be used. Bands shall be secured by angle or strap connections.

(d) **Plastic Pipe:**

(1) **Bell and Spigot Joints:** Gaskets shall be rubber O-rings. Just before jointing, O-ring and gasket seat shall be cleaned of dirt and other foreign material and coated with a flax soap lubricant. Pipe sizes less than 48" may be joined by any method which fully seats joints without damaging pipe; larger pipe sizes shall be joined with a mechanical puller.

(2) **Split Coupling Joints:** Joints shall be sealed with flexible plastic gasket material placed on entire circumference of pipe in 2 corrugations under coupling on each side of joint. In temperatures below 60°F, gasket material shall be heated prior to placement. Coupling shall be secured with at least 2 stainless steel straps on each side of joint, tightened to create an overlap of coupling.

701-6 CAST-IN-PLACE BOX CULVERTS: Cast-in-place reinforced concrete box culverts shall be constructed in accordance with Section 601.

Concrete base slab or footings shall be placed at least 24 hours before wall forms are placed.

For culverts 4 feet or less in height, walls and top slab may be constructed monolithically. Construction joints shall be vertical.

For culverts more than 4 feet in height, concrete in walls shall be allowed to set for at least 7 days before top slab is placed.

Each wingwall shall be constructed monolithically.

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701-7 BACKFILL: Backfill shall be placed and mechanically compacted in lifts not more than 12" thick (loose). Cast-in-place box culverts shall not be backfilled until concrete has attained at least 2500 psi compressive strength.

(a) **Conduits Under or Within 5 Feet of Pavement:** Backfill shall be sand or sand-gravel compacted to at least 95% of maximum density determined by AASHTO T 99; however, the top 12" of backfill for conduits not under pavement shall be select excavated material or borrow material.

(b) **Conduits More Than 5 Feet From Pavement:** Backfill may be sand, sand-gravel, select excavated material or borrow material; however, the top 12" shall be select excavated material or borrow material. Backfill shall be compacted to at least the density of undisturbed surrounding ground.

(c) **Detection Tape:** For plastic pipe, a metallic detection tape shall be installed just above pipeline.

(d) **Steel Pipe:** Backfill for steel pipe shall have at least 1500 ohm-cm resistivity and a pH of at least 5.

701-8 JACKED OR BORED PIPE:

(a) **General:** Pipes 30" diameter and greater shall be jacked, and pipes less than 30" shall be bored.

Work shall begin at outfall end of pipe when possible. When grade at jacking or boring end is below ground surface, pits shall be excavated for conducting operations and placing joints of pipe. Sheet piling and bracing shall be provided to prevent earth caving.

For pipe with bell joints, if outside bell diameter exceeds outside barrel diameter by more than 1", pipe shall be cased or pressure grouted its full length. Casing shall be an approved type and size.

(b) **Jacking:** Heavy duty jacks for forcing pipe through embankment shall be provided. Even pressure shall be applied to all jacks and shall be transmitted to pipe end through a jacking head designed so that pressure is uniformly applied around ring of pipe.

Pipe shall be set on guides fastened together to support pipe in proper direction at correct grade. Cushioning material shall be provided between sections of concrete pipe.

Material shall be excavated ahead of pipe and removed through pipe. Excavation shall not extend more than 2 feet beyond forward end of pipe. Distance shall be reduced when necessary to prevent damage to embankment.

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A steel cutting edge may be used around forward end of pipe, constructed so that it will transmit pressures uniformly around ring of pipe.

Jacking shall continue without extended interruption, to prevent pipe from becoming set in embankment.

Pipe shall not vary more than 1" in 10 feet from established line and grade.

(b) **Boring:** Boring shall be done mechanically, using a pilot hole approximately 2" in diameter. Pilot hole shall extend through embankment and shall be checked for line and grade before boring begins. Variations from line and grade shall not exceed those specified for jacking. Pilot hole shall serve as centerline of larger diameter hole to be bored.

Use of water and other fluids with boring operations will be permitted only to lubricate cuttings. Jetting will not be permitted.

In unconsolidated soil, a gel-forming colloidal drilling fluid consisting of at least 10% high-grade bentonite may be used to consolidate cuttings of bit, seal walls of hole, and furnish lubrication for removal of cuttings and installation of pipe.

Overcutting in excess of 1" shall be remedied by pressure grouting entire length of installation.

701-9 ACCEPTANCE: Prior to final inspection of project, all new and relaid conduit shall be cleaned of debris and soil.

Existing conduit which was extended shall also be cleaned of debris and soil within project limits.

Plastic pipe shall not exceed a vertical deflection of more than 5%.

After plastic pipe has been backfilled for at least 30 days, a mandrel sized at 95% of inside diameter of pipe shall be pulled through pipe. Pipe failing this test shall be removed and replaced with new pipe.

701-10 MEASUREMENT: Quantities of conduit for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

No measurement for payment will be made for excavation, bedding, geotextile fabric or backfill, except for removal and replacement of unstable foundation material as specified under Subsection 701-3.

701-11 PAYMENT: Payment will be made at the contract unit price per linear foot for the specified conduit sizes and types.

701-12 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
70101--	___" Storm Drain Pipe	Linear Foot
70102--	___" Reinforced Concrete Pipe	Linear Foot
70103--	___" Reinforced Concrete Pipe Arch	Linear Foot
70104--	___" Reinforced Concrete Box Culvert	Linear Foot
70105--	___" Bituminous Coated Corrugated Steel Pipe	Linear Foot
70106--	___" Bituminous Coated Corrugated Steel Pipe Arch	Linear Foot
70107--	___" Polymer Coated Corrugated Steel Pipe	Linear Foot
70108--	___" Polymer Coated Corrugated Steel Pipe Arch	Linear Foot
70109--	___" Plastic Pipe	Linear Foot
7011000	Relaid Pipe	Linear Foot
70111--	___" Jacked or Bored Drain Pipe	Linear Foot

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SECTION 702

DRAIN MANHOLES, INLETS AND JUNCTION BOXES

702-1 DESCRIPTION: This work consists of constructing and adjusting storm drain manholes, inlets and junction boxes.

702-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Portland Cement Concrete (Class 6A4000)	1005
Reinforcing Steel	1006-1
Brick	1010-1
Precast Concrete Drainage Units	1017
Frames, Grates and Covers	1011-5
Plastic Gasket Material	1015-2
Bedding Material	1001-9
Metalwork Paint	1012-4

702-3 CONSTRUCTION:

(a) **General:** Excavation shall extend 18" from outside of structure on all sides. Structures shall be set on a 6" compacted thickness of bedding material if foundation soil is stable; if foundation soil is unstable, unstable soil shall be removed as directed and replaced with bedding material, and payment therefor will be made as extra work in accordance with Subsection 10-4. Bedding material shall be compacted in accordance with Subsection 701-3. At time structure is placed, excavation shall be dry.

Pipes shall be flush with inside walls of structure. Completed new or adjusted structures shall be cleaned of dirt and debris.

(b) **Brick Structures:** Concrete foundations for brick structures shall be constructed in accordance with Section 601 and shall be placed 24 hours before brickwork is begun. Brick shall be clean, wetted immediately before laying, and laid on a full mortar bed. Joints between courses of bricks shall be a uniform thickness of 3/8". If new work is to be joined to existing or unfinished work, contact surfaces shall be cleaned and moistened.

No water shall be permitted to stand or run on brickwork until mortar has set. Inside and outside surfaces of structure shall be plastered with 1/2" thick mortar.

(c) **Concrete Structures:** Cast-in-place concrete structures shall be constructed in accordance with Section 601.

Joints between precast concrete units shall be sealed with flexible plastic gasket material.

Prior to installing gasket materials, the gasket seat shall be cleaned of dirt and other foreign matter and shall be dry. At temperatures below 60°F, gasket material shall be heated before installation.

(d) **Pipe Connections:** At pipe connections with structure, a 1/2" diameter bead of hydrophilic elastic sealant shall be placed around pipe at center of structure wall and also along center of wall opening. Space between pipe and wall shall then be grouted up from both sides of wall.

(e) **Adjusting Structures:** If grade adjustment of existing structures is required, frames, covers and gratings shall be removed and structure walls reconstructed as specified for new work. Frames, covers and grates shall be cleaned and placed in good repair (or replaced, if specified).

Structures may also be adjusted with metal adjusting rings connected to existing ring by either welding at least 30% of circumference or by using an epoxy system designed for metal-to-metal adhesion.

(f) **Frames, Covers and Grates:** Frames shall be set in a full mortar bed. Nongalvanized parts shall be coated with metalwork paint.

(g) **Backfill:** Backfill shall be select excavated material or borrow material; sand will not be permitted. Backfill shall be placed in lifts not more than 12" thick (loose).

(1) **Paved Areas:** Backfill shall be compacted to at least 95% of maximum density determined by AASHTO T 99.

(2) **Nonpaved Areas:** Backfill shall be compacted to at least the density of undisturbed surrounding ground.

702-4 MEASUREMENT: New and adjusted inlets, manholes and junction boxes will be measured per each. Trench drains will be measured by the linear foot.

702-5 PAYMENT: Payment will be made at the contract unit prices, which includes excavation, bedding and backfill.

702-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
70201--	Curb Inlet (Type)	Each
70202--	Double Curb Inlet (Type)	Each
70203--	Grate Inlet (Type)	Each
70204--	Double Grate Inlet (Type)	Each
70205--	Weir Inlet (Type)	Each
7020600	Yard Drain Inlet	Each
70207--	Drain Manhole (Type)	Each
70208--	Junction Box (Type)	Each
70209--	Trench Drain (___" Width)	Linear Foot
7021000	Adjusting Drain Manholes, Inlets and Junction Boxes	Each

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SECTION 703

PIPE UNDERDRAINS

703-1 DESCRIPTION: This work consists of furnishing and constructing pipe underdrain systems.

703-2 MATERIALS: Materials shall conform to the following Subsections:

Plastic Pipe	1015-4
Bedding Material	1001-9
Geotextile Fabric	1022-8

703-3 CONSTRUCTION:

(a) **Perforated Pipe:** Trench shall be lined with geotextile fabric and a layer of bedding material at least 3" thick placed in bottom of trench before pipe is laid. Pipe shall be securely jointed and firmly embedded in bedding material. Upgrade ends of pipe shall be capped or plugged and exposed ends shall be covered with galvanized hardware cloth.

Pipe shall be backfilled with bedding material to at least 3" over pipe. Remainder of backfill shall be select excavated material placed in layers not more than 12" thick (loose) and compacted as directed.

(b) **Nonperforated Pipe:** Pipe sections shall be securely jointed, joints wrapped with 24" wide geotextile fabric and backfilled with select excavated material in layers not more than 12" thick (loose) compacted as directed. Exposed outfall ends of pipe shall be covered with galvanized hardware cloth.

703-4 MEASUREMENT: Quantities of pipe underdrains for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

703-5 PAYMENT: Payment for pipe underdrains will be made at the contract unit prices per linear foot, which includes excavation, bedding material, geotextile fabric, backfill and hardware cloth.

703-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
70301--	___" Perforated Pipe Underdrain	Linear Foot
70302--	___" Nonperforated Pipe Underdrain	Linear Foot

SECTION 704

REVETMENTS AND CHANNEL PAVING

704-1 DESCRIPTION: This work consists of constructing slope revetments and paving drainage channels.

When an item for "Flexible Revetment" is included in the contract, the contractor has the option of constructing revetments of either stone, cellular concrete block or sacked concrete.

704-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Portland Cement Concrete (Class 6A4000)	1005
Reinforcing Steel	1006-1
Stone	1001-11
Cellular Concrete Blocks	1010-5
Geotextile Fabric	1022-8

704-3 CONSTRUCTION:

(a) **General:** Slopes to be revetted and channel areas to be paved shall be dry. Logs, stumps and other undesirable material shall be removed and areas brought to required grade and compacted to at least the density of surrounding undisturbed ground.

All revetments, except cast-in-place concrete, shall be placed on geotextile fabric.

(b) **Geotextile Fabric:** Ends of fabric shall be buried as specified. Adjacent fabric strips shall be lapped at least 10" and pinned at maximum 5-foot intervals.

(c) **Cast-in-Place Concrete:** Before concrete is placed, 1/4" premolded expansion material shall be placed around piles, columns, etc.

Slope paving shall commence at toe and progress upslope. Paving of other areas shall be placed as directed. Concrete shall be placed, consolidated and cured in accordance with Section 502.

(d) **Stone Revetment:** Toe and end walls shall be constructed by placing stone in trench lined with geotextile fabric. Placement of stone shall begin at bottom of slope and progress upslope. Openings between stones shall not expose fabric.

(e) **Cellular Concrete Block Revetment:** Placing of blocks shall commence in a trench at toe and progress upslope. Each block shall be laid flat on slope and bedded against adjoining blocks.

In lieu of placing geotextile fabric and blocks separately, revetment may be constructed of mattresses consisting of concrete blocks preset on geotextile fabric with an adhesive. Both blocks and geotextile fabric shall be approved products. If mattresses are used, foregoing placement

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modified requirements may be modified as required to permit proper placement of mattress panels; however, the 10" fabric overlap between adjacent panels shall apply.

After completion of revetment, topsoil shall be spread over revetment to fill cell openings and area shall be seeded and fertilized in accordance with Section 903.

(f) **Sacked Concrete Revetment:** Concrete for sacked revetment shall be wet-batched. Sacks shall be burlap uniformly filled to approximately 3/4 cubic foot. Open end shall be folded under bag during placement. Sacks of wet-batched concrete shall be placed in contact with adjacent sacks and tamped into position. Placement of sacked concrete on slopes shall begin at toe and progress upslope. Sacked concrete for other areas shall be placed as directed.

704-4 MEASUREMENT: Quantities for payment will be the contract quantities, adjusted as required due to plan errors or plan changes.

Design quantities are based on surface area of revetment and channel paving. Site preparation, toewalls and sidewalls, geotextile fabric, premolded expansion material and topsoil will not be measured for payment.

704-5 PAYMENT: Payment for revetments and channel paving will be made at the contract unit price per square yard.

Payment for seed and fertilizer will be made in accordance with Section 903.

704-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
7040100	Flexible Revetment	Square Yard
7040200	Cellular Concrete Block Revetment	Square Yard
7040300	Stone Revetment	Square Yard
7040400	Sacked Concrete Revetment	Square Yard
70405--	___" Cast-in-Place Concrete Revetment	Square Yard
70406--	___" Concrete Channel Paving	Square Yard

SECTION 705

RIPRAP

705-1 DESCRIPTION: This work consists of furnishing and placing riprap for erosion protection.

705-2 MATERIALS: Materials shall conform to the following Subsections:

Riprap	1001-11
Geotextile Fabric	1022-8

705-3 CONSTRUCTION: Areas on which riprap is to be placed shall be graded to required section and compacted as directed. Geotextile fabric shall be placed on areas prior to placing riprap. Ends of fabric shall be buried for anchorage, and adjacent fabric strips shall be lapped at least 10" and pinned at maximum 5-foot intervals.

Riprap shall be placed by methods that do not damage geotextile fabric. Larger stones shall be placed first and smaller stones used to fill in areas between larger stones so that no geotextile fabric is exposed. Surface of completed riprap installation shall be uniform.

When placement in water currents is required, riprap shall be placed by methods that compensate for drift.

705-4 MEASUREMENT:

(a) **Square Yard:** The quantity of riprap for payment will be the contract quantity, adjusted as required due to plan errors or plan changes.

(b) **Cubic Yard:** Measurement will be made by the cubic yard, truck measure, at jobsite. Materials delivered by weight will be measured by the ton from certified weight tickets, and divided by 1.5 to determine pay quantity.

(c) **Ton:** Measurement will be made by the ton from certified weight tickets.

705-5 PAYMENT: Payment will be made at the contract unit price, which includes geotextile fabric.

705-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
70501--	___ " Thick Riprap	Square Yard
70502--	___-lb Riprap	Cubic Yard
70503--	___-lb Riprap	Ton

SECTIONS 801-805 ARE REMOVED IN LIEU OF SPECIAL PROVISIONS

SEE <http://brprojects.com/design-and-construction-resources/master-specifications/>

PART IX
MISCELLANEOUS CONSTRUCTION

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SECTION 901

METAL RAILINGS

901-1 DESCRIPTION: This work consists of furnishing and constructing beam type highway guardrail and steel pipe railings.

901-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Portland Cement Concrete	1005
Reinforcing Steel	1006-1
Structural Steel	1011-1
Steel Pipe	1011-12
Metal Guardrail	1014-9
Guardrail Posts and Spacer Blocks	1014-10
Hardware	1014-11
Wire Rope and Fittings	1014-12

901-3 CONSTRUCTION:

901-3.1 Guardrail:

(a) **Posts:** Posts shall be aligned and set plumb.

(1) **On Structure:** Bolts shall be drawn tight. Bolts shall be of sufficient length to extend beyond nuts.

(2) **Off Structure:** Posts may be driven, provided method of driving does not damage posts. Posts set in drilled or dug holes shall be backfilled as directed. When posts are placed within existing surfaced areas, surface material shall be replaced in kind.

(3) **Rails:** Rails shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond nuts. Holes for special details may be field drilled or punched.

901-3.2 Pipe Railing: Pipe railing shall be adjusted prior to being fixed in place to ensure proper matching at abutting joints and correct alignment. Holes for field connections shall be drilled with railing at proper grade and alignment. Bolts shall be drawn tight.

901-4 MEASUREMENT: Quantities of railings for payment will be the contract quantities, adjusted as necessary if the engineer makes changes to adjust to field conditions, if plan errors are proven, or if design changes are made.

Concrete, reinforcing steel and hardware for railings will not be measured for payment.

901-5 PAYMENT: Payment for railings will be made at the contract unit price per linear foot.

901-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9010100	Guardrail	Linear Foot
9010101	Guardrail (Thrie Beam)	Linear Foot
9010102	Guardrail (Double Thrie Beam)	Linear Foot
9010200	Blocked Out Guardrail	Linear Foot
9010300	Guardrail Anchor Section (Breakaway Cable Terminal)	Linear Foot
9010400	Guardrail Anchor Section (Trailing End)	Linear Foot
9010401	Guardrail Anchor Section (Trailing End) (Thrie Beam)	Linear Foot
9010500	Guardrail Transition	Linear Foot
9010501	Guardrail Transition (Thrie Beam)	Linear Foot
9010600	Steel Pipe Railing	Linear Foot

SECTION 902

FENCING

902-1 **DESCRIPTION:** This work consists of furnishing and constructing fences and gates.

902-2 **MATERIALS:** Materials shall conform to the following Sections and Subsections.

Portland Cement Concrete	1005
Reinforcing Steel	1006-1
Chain Link Fence and Gates	1014-1
Field Fencing Barbed Wire	1014-2
Woven Wire	1014-3
Posts and Braces	1014-4
Gates and Hardware	1014-5, 1014-6, 1014-7
Wood Fencing	1014-8

The same type chain link fencing shall be used throughout the project. The same type, shape and treatment of posts shall be used throughout a section of fence.

902-3 **CONSTRUCTION:** When posts, braces or anchors are to be embedded in concrete, the contractor shall install temporary braces to hold posts in proper position until concrete has set sufficiently to hold posts. Posts shall remain undisturbed for at least 3 days after concrete is placed. Portable mixing of concrete will be permitted. Concrete shall be consolidated by tamping or vibrating.

Tops of footings shall extend slightly above ground and shall be troweled to a smooth finish sloped to drain away from posts. Posts, braces and other units shall be centered in footings.

Cut areas of treated timber shall be given 2 coats of preservative.

Fence wire shall be stretched taut. Electrical ground rods shall be installed along each segment of new or rebuilt metal fence, regardless of type fence post used, at maximum 500-foot intervals.

902-3.1 Chain Link Fence:

(a) **Fence Installation:** Pull posts shall be placed not more than 200 feet apart in straight runs and at each vertical angle greater than 20°. Corner posts shall be placed at each horizontal angle greater than 20°. Corner and pull posts shall have a horizontal brace and tie rod on each side of posts. Horizontal brace and tie rod shall be connected to adjacent line posts.

Posts shall be permanently positioned, anchorages set, and top rail or tension wires secured to posts before fabric is placed. Ends of fabric shall be secured by stretcher bars threaded through loops of fabric and secured to posts by clamps with bolts and nuts.

Fabric shall be placed by securing one end and applying sufficient tension to remove slack before making attachments. Tensioning shall be commensurate with air temperatures at time of installation to prevent undue sagging or tensioning of fabric due to changing temperatures. Fabric shall be fastened to line posts at approximately equal spaces and to top rail (or top tension wire) and bottom tension wire with tie wires or bands.

(b) **Gate Installation:** Gate installation shall include gate frames, stretcher bars, filler fabric, latches, stops, locking device, padlocks, hinge, gate posts with braces, tie rods, turnbuckles, caps another fittings as specified or required for complete installation.

Clamps for attaching hardware shall be tightened. Bottom of gate shall clear ground at least 3" at all points in its swing. Stops with latches or other means for holding gate open shall be provided, placed to prevent damage to gate or fence by overswing. Stops shall be provided at centerline of fence to arrest swing of closed gate.

902-3.2 Rebuilt Fence: The contractor shall take down, move back and rebuild existing fence. Fence shall be rebuilt in the same manner as specified for new fence. Rebuilt ornamental fence, picket fence or other special type fence shall be equal to existing fence.

902-4 MEASUREMENT:

(a) **New Fence:** New fence will be measured by the linear foot between outside of end posts for each continuous run of fence, exclusive of gates.

(b) **Gates For New Fence:** Gates for new fence will be measured per each for single swing gates, and per double gate for double swinging gates.

(c) **Rebuilt Fence:** Rebuilt fence will be measured by the linear foot between outside of end posts for each continuous run of fence, including gates.

(d) **Intersecting Fences:** New fence required for connections of intersecting fences to new or rebuilt fence will be included in the measurement of the new or rebuilt fence.

902-5 PAYMENT: Payment for fences and gates will be made at the contract unit prices.

902-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
90201--	Chain Link Fence (___-Ft. Height)	Linear Foot
90202--	___-Ft. Chain Link Gate, 4-Ft. Height	Each
90203--	___-Ft. Chain Link Gate, 5-Ft. Height	Each

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<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
90204--	___ -Ft. Chain Link Gate, 6-Ft. Height	Each
90205--	___ -Ft. Chain Link Double Gate, 4-Ft. Height	Double Gate
90206--	___ -Ft. Chain Link Double Gate, 5-Ft. Height	Double Gate
90207--	___ -Ft. Chain Link Double Gate, 6-Ft. Height	Double Gate
9020800	Barbed Wire Fence	Linear Foot
9020900	Combination Mesh and Wire Fence	Linear Foot
9021000	Field Fence Walk Gate	Each
9021100	Field Fence Single Drive Gate	Each
9021200	Field Fence Double Drive Gate	Double Gate
9021300	Rebuilt Fence	Linear Foot
902140-	___ -Ft. Wood Fence	Linear Foot
9021500	Remove and Salvage Fence	Linear Foot

SECTION 903

EROSION CONTROL

903-1 DESCRIPTION: This work consists of providing materials and performing work for erosion control.

903-2 MATERIALS: Materials shall conform to the following Sections and Subsections.

Topsoil	1022-1
Seed	1022-3
Fertilizer	1022-2
Straw Mulch	1022-5
Asphalt Mulch	1022-6
Fiber Mulch	1022-5
Slab Sod	1022-9
Excelsior Mat	1022-7.2
Straw Mat	1022-7.1

903-3 CONSTRUCTION: Installation of temporary erosion control features shall be coordinated with construction of permanent erosion control features to ensure effective erosion control at all times.

903-3.1 Temporary Erosion Control: The contractor shall prevent transmission of soil particles into streams, canals, lakes, reservoirs or other waterways. Except as necessary for construction, excavated material shall not be deposited in streams or impoundments, or in a position close enough to be washed into waterways by high water or runoff.

Lands or waters outside construction limits shall not be disturbed, except as authorized. The contractor shall not unnecessarily strip vegetation near stream banks.

The engineer may limit exposure of unprotected earth and may direct the contractor to provide immediate permanent or temporary erosion or pollution control measures to prevent contamination of streams, lakes, reservoirs, canals or other impoundments or prevent detrimental effects on property outside the right-of-way.

When directed, the contractor shall place temporary seed, fertilizer, mulch, sandbags and hay bales; and shall construct silt fences, slope drains, sediment check dams and sediment basins. Earth berms shall be constructed as needed to direct water away from slopes.

(a) **Temporary Seeding, Fertilizing and Mulching:** Seeding, fertilizing and mulching shall be performed in accordance with Subsection 903-3.2, modified as follows. Ground preparation shall be limited to blading the area; grass seed shall be a fast-growing species suitable to the area; application rates of seed, fertilizer and mulch may be reduced when directed.

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(b) **Sandbags and Hay Bales:** Sandbags shall be 1 cubic foot burlap bags, filled at least 3/4 full with sand. Hay bales shall be standard size bales and shall be secured by stakes.

(c) **Slope Drains:** Slope drains shall be constructed of pipe, riprap or other suitable material, with riprap protection at the discharge end.

(d) **Sediment Basins:** Sediment basins shall be excavated to collect silt, and shall be cleaned out as necessary to maintain their effectiveness. Basin outfall shall be riprap protected.

(e) **Sediment Check Dams:** Check dams shall be constructed in ditches, and shall consist of logs and brush or fencing.

(f) **Silt Fencing:** Silt fencing shall be geotextile fabric, either wire-supported or self-supported, attached to posts.

(g) **Removal of Temporary Erosion Control Features:** Temporary erosion control features existing at the time of construction of permanent erosion control features shall be removed or incorporated into the soil in such manner that no detrimental effect will result. The engineer may direct that temporary features be left in place.

903-3.2 Permanent Erosion Control:

903-3.2.1 Topsoil: Where specified, prior to seeding or slab sodding, topsoil shall be uniformly spread over areas and lightly compacted.

903-3.2.2 Seeding and Fertilizing: Seed beds shall be disked and pulverized at least 3" deep; then leveled and lightly rolled prior to seeding. Seed shall be applied by one of the following methods:

(a) **Broadcast:** Seed and fertilizer shall be uniformly spread by hand or mechanical methods. If hand spreading is used, seed and fertilizer shall be sown in 2 directions at right angles to each other.

(1) **Fertilizer:** Fertilizer shall be applied at the following rate:\

<u>Type</u>	<u>Pounds Per Acre</u>
8-8-8	1,000
12-12-12	667
13-13-13	615
16-16-16	500

(2) **Seed:** Seed shall be sown at the following rate:

	<u>Seed Mixture and Rate/1000 SF</u>
March-September	1 Lb Hulled Bermuda
October-February	2 Lb Unhulled Bermuda and 7 Lb Winter Rye

(b) **Hydroseeding:** Seed, fertilizer, mulch and tackifier shall be placed in a single mechanical operation at the following rates:

Planting Mixture and Rate (Lb/1000 SF)						
	Hulled Bermuda Seed	Unhulled Bermuda Seed	Winter Rye Seed	Water Soluble Fertilizer	Fiber Mulch	Soil Tackifier
March- September	1	-	-	30	35	1.5
October- February	-	2	7	30	35	1.5

903-3.2.3 Watering: Unless soil is wet or rainfall is imminent, sodded or broadcast seeded areas shall be watered at rate of 5 gal/sy immediately after seed is placed. When necessary, seeded areas shall be periodically watered until final acceptance.

903-3.2.4 Mulching:

903-3.2.4.1 Straw Mulch: Straw mulch shall be spread on seeded areas at rate of 2 ton/acre.

903-3.2.4.2 Asphalt Mulch: Emulsified asphalt shall be sprayed on seeded or mulched areas at rate of 0.1 gal/sy.

903-3.2.4.3 Fiber Mulch: Fiber mulch shall be spread on seeded areas at rate of 35 lb/1000 sf.

903-3.2.5 Erosion Blanket: Erosion control blankets shall be straw or excelsior mats and shall be placed on seeded areas.

On slopes, blanket strips shall be placed either transverse or parallel to slope. Blanket shall be turned down into 6" anchor slots at top and bottom of slope. Mats shall be stapled to ground at maximum 6-foot intervals staggered on adjacent rows. Straw mats shall be overlapped 6" on ends and sides; excelsior blanket strips shall be tightly butted with adjacent strips at ends and sides.

In ditches, blanket strips shall be placed parallel to ditch, beginning at downstream end. Sides and ends of excelsior strips shall be tightly butted with adjacent strips; sides and ends of straw mats shall be turned down into 6" deep anchor slots at ends and sides. Mats shall be stapled to ground at maximum 4-foot intervals, staggered on adjacent rows.

903-3.2.6 Slab Sod: Areas to be slab sodded shall be disked and pulverized at least 3" deep. Approximately 90% of the required fertilizer shall be placed on the area prior to placing sod, and the remainder of the fertilizer shall be broadcast after sod is placed. Sod shall be rolled or tamped after placement.

903-4

903-4 MEASUREMENT:

(a) Temporary Erosion Control:

(1) **Seed, Fertilizer and Mulch:** Measurement will be made in accordance with Heading (b) below.

(2) **Sandbags, Hay Bales, Sediment Basins and Sediment Check Dams:** Measurement will be made per each.

(3) **Silt Fencing and Slope Drains:** Measurement will be made by the linear foot.

(b) Permanent Erosion Control:

(1) **Topsoil:** Topsoil will be measured by the cubic yard, truck measure, at jobsite.

(2) **Seed:** Seed will be measured by the pound.

(3) **Fertilizer:** Fertilizer will be measured by the pound. The estimated quantity shown in the plans is based on Type 8-8-8 fertilizer. If other types are used, the measured quantities will be multiplied by the following factors to determine pay quantities:

<u>Type</u>	<u>Factor</u>
12-12-12	1.5
13-13-13	1.625
16-16-16	2.0

(4) **Water:** Water will be measured in units of 1,000 gallons; however, water used in hydroseeding slurry will not be measured for payment.

(c) **Slab Sod, Mulch and Erosion Control Mats:** Quantities of slab sod, mulch and erosion control mats for payment will be the contract quantities, adjusted as necessary if the engineer makes changes to fit field conditions, if plan errors are proven, or if design changes are made.

903-5 PAYMENT: Payment will be made at the contract unit prices.

903-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9030100	Temporary Sand Bags	Each
9030200	Temporary Hay Bales	Each
9030300	Temporary Sediment Basins	Each
9030400	Temporary Sediment Check Dams	Each
9030500	Temporary Silt Fencing	Linear Foot
9030600	Temporary Slope Drains	Linear Foot
9030700	Topsoil	Cubic Yard

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9030800	Seed	Pound
9030900	Fertilizer	Pound
9031000	Water	M-Gallons
9031100	Straw Mulch	Square Yard
9031200	Asphalt Mulch	Square Yard
9031300	Fiber Mulch	Square Yard
9031400	Erosion Control Mat	Square Yard
9031500	Slab Sod	Square Yard

904-1

SECTION 904

LANDSCAPING

904-1 DESCRIPTION: This work consists of furnishing plant materials and performing landscaping work.

904-2 MATERIALS: Materials shall conform to the following Sections and Subsections:

Topsoil	1022-1
Fertilizer	1022-2
Plants	1022-4

904-3 CONSTRUCTION:

(a) **Handling and Storage:** The contractor shall protect balled and burlapped (B & B) plants and bare root plants from drying out by covering root system with mulch, wood chips or other suitable materials and watering root system and foliage as necessary. Plants shall be protected from drying winds and sun. Plants shall be lifted from bottom only.

Container grown plants shall be kept moist.

(b) **Planting Season:** Unless otherwise authorized, planting shall be performed as early as practical during winter from November 1 to April 15.

Work shall be suspended when air temperature falls below 32° F, wind velocity is excessive, ground is frozen or too wet, or continuation of prevailing weather would likely cause unsatisfactory results.

(c) **Plant Pits:** Plants shall be set plumb in center of dug pits at such depth that, after settlement, crown of plant will be at its normal relation with ground surface. Soil in bottom of plant pits shall be loosened and broken up to a depth of 6" prior to setting plants.

Backfill soil for plant pits shall be composed of the following:

5 parts topsoil
3 parts rotted pine bark
1 part weed-free manure
1 part coarse sand

Backfill shall be placed and water-settled around plant to ground surface. Root stimulant fertilizer shall be mixed with water at rate recommended by manufacturer. A levee 3" high shall be formed around perimeter of plant pit.

(d) **Plant Beds:** Vegetation and debris shall be removed from plant beds and areas treated with an approved preemergence herbicide in accordance with manufacturer's recommendations.

The following materials shall be added to plant beds:

<u>Material</u>	<u>Rate/1000 SF</u>
Compost	3 cy
Rotted Pine Bark	7 cy
Weed-free Manure	3 cy
Fertilizer	20 lb

After all materials are added, plant beds shall be rototilled to a depth of 12", after which beds shall be raked smooth and grass, sticks and debris removed. Tops of beds next to walks or buildings shall be 2" higher than adjoining walks or ground.

(e) **Weed Control Fabric:** Before placing mulch, an approved plastic weed control fabric shall be installed on the beds. The fabric shall be designed to block weed growth and light to plant bed soil while allowing for air and water filtration. Fabric shall be at least 18 mils thick and shall be installed in accordance with the manufacturer's instructions.

(f) **Mulching:** A top dressing of mulch shall be placed to a depth of 3" within plant saucers and in plant beds. Mulch shall be pine straw, pine bark, cypress bark, eucalyptus bark or other approved mulch; however, neither fresh nor rotted bark shall be used.

(g) **Maintenance:** Plant areas shall be watered immediately after planting and at intervals necessary to maintain plants in healthy condition. Plant areas shall be kept free of debris, and shall be weeded at intervals not exceeding 10 days.

Dead, dying or damaged plants shall be replaced.

904-4 MEASUREMENT:

(a) **Plants:** Furnishing and planting the various types and sizes of plant materials will be measured per each. No measurement for payment will be made for pit preparation, topsoil, fertilizer, rotted pine bark, manure, sand, watering, staking, plant maintenance or plant replacement.

(b) **Plant Beds:** Plant bed preparation will be measured by the square yard. No measurement will be made for vegetation removal, herbicide, compost, rotted pine bark, manure or fertilizer.

(c) **Weed Control Fabric:** Weed control fabric will be measured by the square yard.

(d) **Top Dressing Mulch:** Top dressing mulch will be measured per square yard.

(e) **Landscaping:** When an item for "Landscaping" is included in the contract, the furnishing of all plant materials and performing all required landscape work under the contract will be measured on a lump sum basis.

904-5

904-5 PAYMENT: Payment for plants, plant beds and top dressing mulch will be made at the contract unit prices.

Payment under the "Landscaping" item will be made at the contract lump sum price.

904-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
90401--	Plant (Type, Size)	Each
9040200	Plant Beds	Square Yard
9040300	Weed Control Fabric	Square Yard
9040400	Top Dressing Mulch	Square Yard
9040500	Landscaping	Lump Sum

SECTION 905

TRAFFIC SIGNS, STRIPING AND RAISED MARKERS

905-1 DESCRIPTION: This work consists of furnishing and placing traffic signs, striping and raised markers in accordance with the MUTCD.

905-2 MATERIALS: Materials shall conform to the following Sections and Subsections.

Sign Backing (Blanks)	1020-1
Reflective Sign Sheeting	1020-1
Sign Posts	1020-1
Barricade Warning Lights	1020-1.1
Structural Aluminum	1020-1.2
Timber	1013
Hardware	1020-1.2(e)
Pavement Striping Tape	1020-2.1(a)
Traffic Paint	1020-2.2.3
Thermoplastic Pavement Markings	1020-2.2.1
Preformed Plastic Pavement Markings	1020-2.2.2
Raised Pavement Markers and Adhesives	1020-3

905-3 CONSTRUCTION:

905-3.1 Signs:

905-3.1.1 Temporary Signs and Barricades: The contractor shall furnish and install temporary construction signs and barricades before construction begins. When construction signs are in place and approved, existing permanent signs that are in conflict with construction signs shall be covered or removed. The contractor shall furnish and install additional signs as necessary during construction, relocate signs on the project when required, maintain signs by cleaning or replacing as necessary, and remove construction signs upon completion of the work.

905-3.1.2 Permanent Roadside Signs: Removal of existing signs shall be coordinated with new sign construction to provide adequate signing at all times.

(a) **Posts:** The contractor shall determine length of post required at each sign location. Posts shall be driven vertical by methods that will not damage posts. Minimum ground penetration shall be 2 feet for delineator and object marker signs, and 3 feet for other signs.

(b) **Sign Faces:** Signs shall be mounted 7 feet above pavement edge to bottom of sign, except that a secondary sign below another sign shall be mounted 4 feet from pavement edge to bottom of sign. Signs shall have a lateral clearance of 2 feet from pavement edge (or face of curb) to edge of sign, except that delineators and object markers on open ditch sections shall have a lateral clearance of 2 feet from shoulder edge to sign.

905-3

Sign shall be oriented at a 93° angle from roadway centerline to avoid specular glare.

(c) **Dead End Installations:** Timber barricades shall be constructed in accordance with Section 603. Beam guardrail shall be installed in accordance with Section 901.

905-3.2 Pavement Striping:

905-3.2.1 Temporary Striping: Temporary centerline and lane line striping shall be placed at end of each day's asphalt pavement removal or surfacing operations on all lanes that are open to traffic. Centerlines and lane lines shall be marked with 4-foot long stripes on 40-foot centers.

Temporary striping for surfaces other than final surface may be made with striping tape, traffic paint or plastic markings. Temporary striping for final surface shall be striping tape placed to avoid conflict with permanent striping. Temporary striping shall be removed after completion of permanent striping (when specified).

905-3.2.2 Permanent Striping:

(a) **Surface Preparation:** Surfaces shall be cleaned of materials that reduce adhesion of new markings. Cleaning shall be done by blast cleaning or grinding. Surfaces shall be kept clean until placement of markings.

Existing markings that are not flaking or peeling do not require removal prior to placement of new thermoplastic or painted markings; however, when preformed plastic markings will replace existing markings, existing markings shall be removed to the extent that at least 75% of pavement surface is exposed prior to placing new markings.

(b) **Weather Limitations:** Markings shall not be applied when pavement is wet nor when air temperature is below 50°F.

(c) **Striping Application:** Striping shall have well defined edges and be free of waviness. Segments shall square off at each end without mist or drip. On concrete pavement, longitudinal striping shall be offset approximately 2" from longitudinal joints.

(1) **Painted Striping:** Paint shall be applied at approximately 130°F to a thickness of 15 mils. Glass beads shall be applied immediately to wet paint at rate of 6 lb/gal of paint by compressed air.

(2) **Thermoplastic Striping:** On concrete surfaces, a binder-sealer recommended by manufacturer shall be applied prior to placement of markings. Marking material shall be applied at approximately 420°F to a thickness of 125 mils for crosswalk, stop line, legend and symbol markings; and 90 mils for other markings. Glass beads shall be applied immediately to molten plastic at rate of 300 lb/ mile.

(3) **Preformed Plastic Markings:** Preformed markings shall be applied by removing release paper, placing marking on surface, and applying sufficient pressure to ensure proper adhesion to surface.

(d) **Protection of Striping:** Traffic shall be prevented from crossing a wet stripe by use of flaggers or other methods. Stripes which have been marred or picked up by traffic shall be repaired, and pavement outside striping cleaned.

905-3.3 Raised Pavement Markers:

(a) **Surface Preparation:** Surfaces on which markers are to be applied shall be cleaned of materials that may reduce bond of adhesive. Surfaces shall be cleaned by blast cleaning or other methods which do not damage surface; however, blast cleaning equipment shall be provided with positive cutoff controls. Surfaces shall be blown dry immediately prior to marker placement.

(b) **Weather Limitations:** Markers shall not be applied when air temperature is below 50° F.

(c) **Marker Application:** Markers shall be placed with bituminous adhesive on asphalt surfaces and epoxy adhesive on concrete surfaces.

(1) **Bituminous Adhesive:** Adhesive shall be applied to surface at approximately 400°F and marker immediately embedded in adhesive.

(2) **Epoxy Adhesive:** Adhesive shall be applied to surface at approximately 95°F and marker immediately embedded in adhesive. Voids in bottom of marker shall be filled with adhesive just before marker placement.

905-4 MEASUREMENT:

(a) Signing:

(1) **Temporary Signs and Barricades:** When the contract does not include a pay item for "Temporary Signs and Barricades," the providing of temporary construction signs and barricades will not be measured for payment.

When a pay item for "Temporary Signs and Barricades" is included in the contract, the furnishing, erecting, maintaining and removing of temporary construction signs and barricades will be measured on a lump sum basis.

(2) **Permanent Signs:** Signs will be measured by the square foot. No measurement will be made for posts.

(3) **Delineators and Object Markers:** Delineators and object markers will be measured per each, including post.

905-5

(4) **Dead End Installations:** Dead end road installations will be measured per each, including piling, posts, sign materials, reflectors, barricades and guardrail.

(b) **Striping:**

(1) **Temporary Traffic Striping:** When the contract does not include a pay item for "Temporary Traffic Striping" the providing of these markings will not be measured for payment.

When the contract includes an item for "Temporary Traffic Striping", the furnishing, placing, maintaining and removing these markings will be measured on a lump sum basis.

(2) **Permanent Markings:** Striping will be measured by the linear foot, exclusive of gaps. Legends and symbols will be measured per each.

(c) **Raised Pavement Markers:** Raised pavement markers will be measured per each.

905-5 PAYMENT: Payment for traffic signs, striping and raised markers will be made at the contract prices.

Partial payments for temporary signs and barricades will be made in accordance with the following schedule;

<u>% of Total Contract Amount Earned</u>	<u>Allowable % of Lump Sum Price for Item</u>
1st Partial Estimate	20
25	40
50	60
75	80
100	100

No direct payment will be made for removing existing pavement markings.

905-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9050100	Temporary Signs and Barricades	Lump Sum
9050200	Traffic Signs	Square Foot
9050300	Delineator	Each
9050400	Object Marker	Each
90505--	(Type) Dead End Installation	Each
9050600	Temporary Traffic Striping	Lump Sum
90507--	Painted Traffic Striping (___" Width)	Linear Foot
90508--	Plastic Traffic Striping (___" Width)	Linear Foot
90509--	Painted Legends and Symbols (Type)	Each
90510--	Plastic Legends and Symbols (Type)	Each
9051100	Raised Pavement Markers	Each

SECTION 906

TRAFFIC SIGNALS

906-1 DESCRIPTION: This work consists of furnishing and constructing new traffic signal systems or modifying existing traffic signal systems.

906-2 MATERIALS: Materials shall conform to the following Sections and Subsections.

Portland Cement Concrete	1005
Reinforcing Steel	1006-1
Signal Heads	1021-1
Loop Detectors	1021-2
Signal Hardware and Equipment	1021-3
Pedestal Anchor Bolts	1021-3(c)
Support Cable	1021-3(d)
Guy Components	1021-3(e)
Signal Cable	1021-3(f)
Junction Boxes	1021-3(g)
Poles	1021-4
Steel Standards and Mast Arms	1021-4(c)

906-3 REGULATIONS AND CODE: Electrical equipment shall conform to NEMA and RMA requirements. Materials and work shall conform to the standards of NEC, ANSI C2 (National Electrical Safety Code), ITE, IMSA and MUTCD.

906-4 GENERAL REQUIREMENTS: If the work involves an existing signal system, equipment designated for salvage shall be protected from damage during removal. During construction, the contractor shall provide for continuous signal operation whenever practical, and shall provide police supervision of traffic at all times signal is not in operation, all at no direct pay.

The contractor shall provide the Traffic Engineer working drawings and equipment submittals for approval before ordering materials and equipment.

Upon completion of signal and controller work, each cabinet shall contain a plastic envelope with a copy of field wiring terminations pertaining to that intersection. The contractor shall submit to the Traffic Engineer equipment manuals, traffic studies, copies of wiring diagrams, and manufacturer's certification letters for each intersection prior to new signals or signal modifications becoming operational.

906-5 ELECTRICAL SERVICE: The contractor shall verify location of power source and arrange for electrical service.

Existing power service shall be used unless a new power source is indicated on plans. Traffic signal control equipment shall preferably be in same quadrant as power source. If power source is not in same quadrant, the contractor shall submit a drawing of proposed changes for approval.

906-6

At each power source, a 1" diameter conduit with conductors shall be attached to service pole and terminated with a threaded service entrance fitting (weatherhead) at a height designated by power company. Wire shall extend at least 2 feet beyond weatherhead.

906-6 FOUNDATIONS: Excavation for mast arm and strain pole foundations shall be drilled with an auger. Excavation for pedestal poles and controller foundations may be made with an auger or by hand. Forms and ground to be in contact with concrete shall be moistened before placing concrete. Concrete shall be Class 6A4000.

Foundations shall be cast monolithically. Exposed portions shall be formed to present a neat appearance. Bottom and sides of concrete foundations shall rest on firm undisturbed ground.

Tops of foundations for poles and signal supports shall be finished at grade of curb top or sidewalk or as directed. Conduit ends and anchor bolts shall be held in place by a template.

Exposed surfaces of concrete shall be given a Class 1, Ordinary Surface Finish in accordance with Subsection 601-10.1.

Tops of mast arm foundations shall be level, and anchor bolts shall extend at least 1/4" above nut.

Conduits terminating in anchor base poles and pedestals shall extend 3" above foundation and be aligned toward handhole.

An additional 2" diameter conduit stub-out shall be installed in foundations for future use. Foundation shall be marked to indicate location of additional conduit and grounding conduit.

906-7 POLES AND MAST ARMS:

(a) **Pedestal Poles:** Poles shall be plumb within 1" at top. Not more than a total of 1/4" of shims shall be used on foundations.

(b) **Mast Arms:** After loading, mast arm shaft shall be plumb within 1" at top. End of mast arm shall be at least 5 feet above top of shaft, and at least 21 feet above bottom of transformer base. Mast arms shall be installed with compression grommet bushing (CGB) connectors in bosses used for cabling.

(c) **Strain Poles:** Poles shall be anchor base type and shall be plumb within 6" at top after support cable tensioning.

(d) **Timber Poles:** Poles shall be set in auger-drilled holes.

Depth of holes shall be at least 20% of pole length, but not less than 6 feet. Hole diameter shall be at least 4" larger than pole butt diameter. Poles shall be plumb within 6" at top after support cable tensioning. Pole shall be backfilled with granular material.

Holes for support cable attachment shall be fitted within 5/8" thimble-eye through bolts and 2 1/2" square curved washers.

Each pole shall have a continuous No. 8 AWG copper wire along length of pole and extending 6" above top of pole. At least 6 feet of copper wire shall be coiled and attached to bottom of pole. Wire shall be stapled to pole with 1 1/2" staples at 6" intervals from butt to 12 feet from butt, and continuing at 1-foot intervals to top of pole.

906-8 GUY WIRE ASSEMBLIES: Guy wire shall be attached to pole with a 5/8" angle thimble-eye bolt through a lift plate fastened to pole by two 3/8" lag screws. Opposite side of pole shall have a 2 1/2" square curved washer, a square nut, and a thimble-eye nut for termination of support cable. An additional square nut shall be used as a locking nut against thimble-eye nut. Hardware shall be tightened against pole.

Excess bolt length shall be sawn to within 1/4" of nut and galvanized coating repaired.

Guy assembly shall have strain insulator, thimble-eye anchor rod, service sleeves, and screw-type anchors.

Guy assemblies shall be tensioned before signal erection.

906-9 SUPPORT CABLE: Support cable with accessories shall be installed between 2 or more poles to provide support and attachment for traffic control equipment. Support cables shall be grounded. Accessories used with support cables shall include strain insulators and 3-bolt clamps. Long strain insulators shall be used as needed for safety clearance. Attachments of support cable shall be made with standard thimble-type hardware.

906-10 SIGNAL HEADS: Signals shall be vertical. Cable suspended heads shall be fitted with a universal hanger. Drop pipes will be allowed only when necessary to provide proper roadway clearance. Disconnect hangers will be required for cable suspended heads.

Mast arm mounted signals shall be installed using an adjustable rigid bracket.

Each bulb in signal head shall be connected to an individual wire from controller. Lamp sockets shall be rotated to position open portion of lamp filament upward.

Each signal head shall be oriented to its lane or crosswalk and secured in place by a locking device incorporated in signal housing and support hardware. Supporting brackets on trunnions shall be used at top and bottom of section assembly to rigidly support all faces. Openings not used for mounting shall be closed with threaded weatherproof plugs.

Signal heads shall be covered with opaque material until placed in service.

906-11 LOOP DETECTOR INSTALLATION: Slots shall be sawn in pavement for installation of vehicle detector loop wire.

906-12

An extension from loop to pavement edge shall be cut to permit wire routing to an adjacent pullbox or conduit through a 1/2" conduit.

Slots shall be cleaned of loose material. Wire shall be pushed into slots with a blunt tool to avoid damaging insulation. No splices will be permitted in loop installation except in the pull-box, conduit fittings or pole. Wiring from pavement to controller box shall be installed in conduit. Wiring from pavement edge to splice shall be twisted 2 to 5 turns per foot. Loop ends shall be spliced to lead-in cable connected inside controller cabinet. Wiring shall be spliced using a connector or by soldering, then encapsulated with electrically insulating waterproof epoxy; however, conduit shall not be filled with epoxy.

Slots shall be filled with sealant.

906-12 PEDESTRIAN PUSHBUTTON: Pushbuttons shall be installed on poles or pedestals at locations where signal head is visible from pushbutton. Pushbuttons mounted on steel poles shall be serviced by wiring inside poles. Wires shall be installed through a 3/4" hole in pole and through back of housing and shall be installed with a rubber grommet. Unused conduit attachment holes shall be plugged. Housing shall be attached to pole using machine or selftapping screws.

Pushbuttons mounted on wood poles shall be wired through conduit. Pedestrian pushbutton signs shall be installed above pushbutton.

906-13 ELECTRICAL: Wires in cabinets shall be neatly laced into cables with nylon lacing or plastic straps.

Conductors shall be installed in conduit except where run is inside poles or suspended from support cable.

After completion of wiring, conduit entering cabinets, pole bases or junction boxes shall be sealed with a removable sealant compatible with cable jacket, insulation and conduit material.

Support cable, metallic cable sheaths, conduit, transformer cases, metal poles and pedestals shall be made mechanically and electrically secure and grounded. Bonding and grounding jumpers shall be No. 6 AWG copper wire. Equipment on timber poles shall be grounded.

Cable from circuit breaker at service to controller shall consist of at least 3 stranded No. 6 AWG THWN copper wires.

At least 6 feet of spare signal, loop lead-in and communication cable shall be installed between controller cabinets of different intersections. Signal, interconnect or communication cable may be lashed to support cable or installed in underground conduit. Lashing material shall be stainless steel for interconnect and aluminum for signal cable.

906-14 CONDUIT INSTALLATION: Underground wiring shall be enclosed in conduit. Conduit connections shall use threaded couplers and be sealed with a waterproof sealant. Coupling of new conduit to existing conduit shall be with a 3-piece coupling.

Threads shall be of sufficient length to permit full-depth coupling. Excessive threads will not be permitted. Ends of conduit installed for future connections shall be threaded, reamed and capped. Couplings shall be tightened until conduit ends are together. Damaged coatings in exposed threads shall be repaired. Exposed threaded ends of conduit shall be terminated with an insulated-throat, ground-type bushing.

Backfill shall be compacted to at least the density of surrounding undisturbed ground. Conduits shall be tested with a mandrel having a diameter 1/4" smaller than inside diameter of conduit.

The contractor may install larger size conduit at no additional pay. No reducing couplings will be permitted in a conduit run.

Underground conduits shall be buried at least 18" below surface. Conduits for loop detectors shall be installed parallel to curbs and a maximum of 2 feet behind back of curb. Conduit shall be jacked or bored under existing pavements and within drip line of trees.

906-15 CONTROL EQUIPMENT: Field wiring in controller cabinets and bases shall be neatly arranged, lashed into cables, routed to terminal blocks, and permanently identified near terminal.

Controller equipment programming shall be provided by the contractor. After programming, controller equipment operations shall be tested with signals off, using signal shutdown switch.

906-16 JUNCTION BOXES: Junction boxes, when specified, are required a minimum of every 150 feet in a conduit run. Backfill shall be compacted to at least the density of surrounding undisturbed ground. Metal covers and conduits shall be bonded together.

Conductors shall be installed clear of metal frames and covers.

Pull box fittings shall be installed at a minimum spacing of 90 feet on conduit longer than 180 feet.

906-17 EMERGENCY VEHICLE PREEMPTION SYSTEM

(a) **Description:** The emergency vehicle preemption system shall employ optical communication to identify the presence of designated priority vehicle and cause the traffic signal controller to advance or hold a desired traffic signal display selected from phases normally available. This communication shall be effective to optical detectors at or near the intersection over a line-of-sight path of up to 1880 feet. The system shall require no action of the vehicle operator other than operation of the "Emitter ON" switch located in the vehicle. The switch is to remain "ON" until the end of the emergency run. The system shall operate on a first-come, first-served or on a selected priority basis. This system shall be designed to yield to other priority demands, such as railroad. The system shall interface with traffic signal controllers without compromising normal operation or existing safety provisions. The Priority Control system shall consist of optical emitters optical detectors, optical detectors cable and phase selectors.

(b) **Components:** The system shall be the 500 Series Opticom Priority Control System as manufactured by 3M or approved equal. The system shall provide the synergy of 4 principal components, matched and proven through integrated testing and extensive functional experience. The matched component system shall be compatible with all types of traffic signal controllers, i.e., electro-mechanical, solid state. Matched components shall provide future system compatibility of all priority control elements.

(1) **Optical Emitter:** Shall be a lightweight, waterproof, light-emitting device with internal, regulated, power supply designed to produce high intensity optical energy from a single source, precisely timed by a crystal controlled circuit.

(2) **Optical Detector:** Shall be a lightweight, waterproof, adjustable, bi-directional optical emitter assembly. Internal circuitry shall transform optical energy from the optical emitter assembly into electrical signals for delivery (up to 1000 feet) via optical detector cable to the phase selection equipment.

(3) **Optical Detector Cable:** Shall be shielded 3-conductor cable with a drain wire and the necessary electrical characteristics to carry power to the optical detector from the phase selector and to carry the optical detector signal to the phase selector. Cable shall have conductors of AWG20(7.28) stranded, individually tinned, copper, color coded as follows:

Orange or delivery of optical power(+).
Blue for optical detector power return (-)
Yellow for optical detector signal.

The conductor shall be shielded with aluminized polyester and have an AWG(7x28) stranded and individually tinned drain wire to provide signal integrity and transient protection. The shield wrapping shall have 20% overlap to ensure shield integrity following conduct and mast arm pulls.

(4) **Phase Selector:** This equipment shall interface between optical detectors and controller unit and provide the following functions while not compromising existing failsafe provisions.

- a. Sufficient power to all optical detectors for the intersection.
- b. Suitable sensitivity to optical detector signal via adjustable range potentiometer.
- c. Differentiation of signals by optical detectors from one or more emitters on a first-come, first served basis.
- d. Outputs to signal the controller to cause selection of the desired phase green display for approaching vehicle. Phase selection shall be located in controller cabinet.

e. Smooth transition to non-priority operation upon passage of vehicle through the intersection.

f. Various phase selected models that take advantage of the phase delivery capability of the variety of traffic controller types.

(c) **Operations:** Approach selection shall be activated by an optically transmitted signal of 14.035 or 9.63 Hz from a single light source or upon actuation of a test switch or remote call signal to phase selector.

The system shall cause traffic controller to select from normally available green phases by activating one of several discrete inputs that will cause controller to execute one of its internal programmable priority phase selection plans.

The system shall provide for up to 3 optical detectors to be connected to each channel to provide adequate optical emitter detection range to allow sufficient time to deliver desired phase selection and to provide continuous line-of-sight contact between optical emitter and detector units.

The system shall allow traffic signal controller to resume normal timing operation after designed signal display is obtained and optical signals have ceased for an appropriate period. The system shall not attempt controller manipulation nor retain priority vehicle calls during periods of "Intersection Flash" operations.

(d) **Installation:** The manufacturer shall provide service before, during and after installation of the priority control system. The manufacturer shall provide certified trained technicians having traffic systems industry experience and operational knowledge of priority control systems.

The contractor shall be responsible for system documentation, including the following:

- (1) Acquire all relevant controller information.
- (2) Determine number of vehicle phases (greens).
- (3) Determine desired greens for priority approaches.
- (4) Determine ring configuration of each controller.
- (5) Establish minimum green times for non-priority phases.
- (6) Establish manipulation methods of each controller type.
- (7) Supply interface information to installer.
- (8) Assist in system checkout prior to purchaser's acceptance by:

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- a. Verifying proper installation per recommended interfaces.
- b. Verifying that optical ranges are properly set.
- c. Verifying that phase selection timings or controller software timings are properly set.

System checkout requirements when using the plug-in version of phase selector must include verification that when 2 plug-in units are used, the controller must recognize high frequency over low frequency and first-come, first-served. All possible conditions of priority must be considered. This may require software or hardware changes in the traffic controller. Software and programming of these controllers is the responsibility of the manufacturer.

(9) Instruct emergency vehicle operators in the operation of the system. Instruction shall include introductory training, periodic training updates, and a leave-behind audio visual self-instruction course for on-going training.

(10) Instruct maintenance personnel in routine maintenance of the system.

(11) Manufacturer's technical support shall include technical service, design engineering, manufacturing engineering and research engineering for system development, process management of priority control components and for training of system users.

(e) **Warranty:** Before final acceptance the contractor shall provide the engineer with a copy of the priority control system manufacturer's warranty for 10 years of operational reliability of the system and interface compatibility with future system components.

The warranty shall state that, provided the priority control system has been properly installed, operated and maintained, component parts of system that prove to be defective in workmanship or material during the first 10 years from date of shipment from the manufacturer will be promptly repaired or replaced by the manufacturer at no cost to the system owner.

906-18 EQUIPMENT TESTING:

(a) **Manufacturer's Tests:** Tests specified herein will not be required if documentation is provided indicating that such tests have been previously completed.

Performance tests may be required on equipment not previously tested or approved.

The contractor shall conduct special tests when equipment or systems are suspected of improper operation, or when additional data is necessary to determine proper operation or conformance with specifications.

A test shall be performed on assembled equipment, cabinet, and control equipment by the manufacturer prior to shipment. Malfunctions or defects shall be corrected and equipment retested. The complete log showing results of test shall be delivered with equipment. Test shall require operation of equipment with each signal circuit connected to an incandescent load of at least 600 watts. Equipment shall operate sequentially and continuously for at least 48 hours in an environment having a minimum temperature of 140° F.

(b) **Insulation Tests:** Insulation tests shall be made between conductors and ground, and between conductors. Tests shall be made before connecting equipment that may be damaged by tests. Readings below 50 megohms, measured with a 1000 volt D.C. insulation tester, will be considered defective.

(c) **Test Documentation:** Documentation shall include a Certificate of Compliance, 2 sets of cabinet wiring drawings, and technical manuals for control equipment.

906-19 MEASUREMENT: Traffic signal systems and removing traffic signals will be measured on a lump sum basis.

906-20 PAYMENT: Payment for traffic control systems and removing traffic signals will be made at the contract lump sum price, which includes furnishing and installing all equipment and materials and performing all work required to complete the signal systems.

906-21 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9060100	Traffic Signal System	Lump Sum
9060200	Remove Existing Traffic Signals	Lump Sum

907-1

SECTION 907

CONCRETE CURBS, WALKS, DRIVES AND INCIDENTAL PAVING

907-1 DESCRIPTION: This work consists of furnishing and constructing portland cement concrete curbs, walks, drives and incidental paving.

907-2 MATERIALS: Materials shall conform to the following Sections and Subsections.

Portland Cement Concrete	
(Class 5.5B3800)	1005
Reinforcing Steel	1006-1
Joint Filler	1007
Curing Compound	1008-1

907-3 CONSTRUCTION:

(a) **Subgrade:** The top 6" of subgrade shall be scarified and recompact to at least 95% of maximum density determined by AASHTO T 99. Subgrade surface shall be moistened at time concrete is placed.

(b) **Forms:** Forms shall be of either wood at least 1½" thick or metal, and shall be such that forms remain in position during concreting.

(c) **Slip-Forming:** Concrete may be placed by slip-form methods. Slip-formed concrete shall be placed with an extrusion machine designed to spread, consolidate and finish concrete in 1 pass of the machine such that minimum hand finishing is necessary. Sliding forms shall be rigidly held together to prevent spreading of forms. After passing of forms there shall be no noticeable slumping of concrete. Finished concrete shall be free from voids. Any additional finishing required shall be performed immediately after placement.

(d) **Integral Curb:** Curb forms shall be fastened to slab forms immediately after completion of pavement finishing. Concrete curbing shall be placed within 30 minutes after pavement has been finished.

Integral curb may be placed after pavement has hardened, provided deformed reinforcing dowel bars of specified size, type and spacing are inserted in concrete immediately after pavement has been finished.

Concrete for curb shall be spaded or vibrated sufficiently to eliminate voids, tamped to bring mortar to surface, floated smooth, and brush finished to a gritty texture. Edges shall be tooled to specified radius.

Curb joints shall match those in pavement and shall extend entirely through curb. Joints shall be filled with same filler used in the pavement, and curb edges at joints shall be tooled to a 1/4" radius.

(e) **Combination Curb and Gutter:** Concrete shall be struck off, spaded or vibrated to eliminate voids, tamped to bring mortar to surface, floated smooth, and brush finished to a gritty texture.

Curb and gutter shall be scored 3" deep at 20-foot intervals. Expansion joints shall be placed in curb and gutter at 100-foot intervals and at beginning and end of curvature at street intersections. Premolded 1/2" thick expansion joint filler shall extend for entire width and depth of curb and gutter, and joint edges shall be tooled to a 1/4" radius.

(f) **Walks, Drives and Incidental Paving:** Concrete shall be struck off, consolidated, tamped to bring mortar to surface, floated smooth, and brush finished to a gritty texture.

(1) **Walks:** Walks shall be scored 1/2" deep at intervals equal to width of walk, and expansion joints shall be placed in walks at 100-foot intervals and at junctions with curbs, drives and other walks. Expansion joints shall consist of 1/2" thick premolded joint filler extending for full width and depth of walk. Premolded 1/4" thick joint material shall be placed around manholes, utility poles, etc. that extend through walks.

(2) **Drives:** Drives wider than 16 feet shall be longitudinally scored 1/2" deep at intervals of not more than 16 feet, and drives longer than 16 feet shall be scored 1/2" transversely at intervals of not more than 16 feet. Expansion joints shall be placed at junctions with curbs and concrete pavements. Expansion joints shall consist of 1/2" thick premolded joint filler extending for full width and depth of drive.

(3) **Incidental Paving:** Paving shall be scored 1/2" deep at intervals of not more than 16 feet in any direction. Paving adjacent to jointed concrete shall be jointed to match adjacent concrete.

(g) **Curing and Protection:** Curing and protection of concrete shall be in accordance with Subsection 502-9.

907-4 MEASUREMENT: Quantities of integral curb, combination curb and gutter, walks, drives and incidental paving for payment will be the contract quantities adjusted as required due to plan errors or plan changes.

907-5 PAYMENT: Payment for integral curb and combination curb and gutter will be made at the contract unit prices per linear foot. Payment for walks, drives and incidental paving will be made at the contract unit prices per square yard.

No direct payment will be made for excavation, backfill or joint filler.

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907-6 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
90701--	Integral Concrete Curb (Type)	Linear Foot
90702--	Concrete Curb and Gutter (Width)	Linear Foot
90703--	___" Concrete Walks	Square Yard
90704--	___" Concrete Drives	Square Yard
90705--	Concrete Step (Width)	Each
90706--	___" Incidental Concrete Paving	Square Yard

SECTION 908

PAINTING

908-1 DESCRIPTION: This work consists of preparing surfaces, and furnishing and applying paint systems.

908-2 MATERIALS: Materials shall conform to the following Subsections.

Organic Zinc Primer and Topcoat System	1012-2
Coal Tar Epoxy-Polyamide System	1012-3
Metalwork Paint	1012-4

908-3 WEATHER LIMITATIONS: Paint shall be applied on dry surfaces when air temperature is above 50°F and relative humidity is below 85%.

908-4 PROTECTION OF THE PUBLIC AND WORK: The contractor shall protect the public and the work against disfigurement by paint materials and damage caused by surface preparation. The contractor shall be responsible for damage caused by the contractor's operations to vehicles, persons or property, including plants and animals, and shall provide protective measures to prevent such damage. Paint stains which result in an unsightly appearance shall be removed or obliterated.

908-5 MIXING PAINT: Paint shall be mixed immediately before application and shall be agitated during application. Thinning shall be in accordance with manufacturer's recommendations.

908-6 SURFACE PREPARATION:

(a) **Uncoated Steel or Iron:** Uncoated metal surfaces shall be blast cleaned to near-white metal. Oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter shall be completely removed except for light shadows, streaks or discolorations caused by rust stain, and mill scale oxides. At least 95% of each square inch of surface area shall be free of visible residues.

Cleaning shall be performed in accordance with SSPC-SP 10 with the following modifications. Anchor pattern shall be 1 to 3 mils. Rate of blast cleaning may vary from one area to the next to achieve desired pattern. Use of recycled steel abrasive blasting materials will be permissible, provided anchor pattern requirements are met and adhesion is not compromised.

Blast cleaned surfaces shall be painted before rusting occurs, preferably within 8 hours after blasting. Blast cleaned surfaces shall be painted the same day or reblasted. Occurrence of rust after cleaning shall be cause for recleaning.

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Surfaces of a casting shall be blast cleaned before casting is machined.

Weld spatter and other undesirable materials shall be removed and sharp edges ground smooth prior to blast cleaning.

(b) **Coated Steel:** Galvanized and prepainted steel shall be cleaned of oil, grease, dirt or other foreign materials and lightly sanded, then treated with wash primer at a minimum dry film thickness of 0.5 mil prior to topcoat application.

(c) **Timber and Lumber:** Timber and lumber shall be cleaned of oil, grease, dirt or other foreign material. Preservatives for treated timber requiring painting shall be pentachlorophenol-petroleum solutions.

(d) **Concrete and Masonry:** Concrete and masonry surfaces shall be cleaned of oil, grease, dirt, dust, loose mortar, curing compound and other foreign material.

908-7 PAINT APPLICATION:

908-7.1 Steel and Iron:

(a) **Surfaces To Be Painted:** When fabrication and cleaning are completed, surfaces not painted during assembly shall be painted with 1 coat of specified paint before damage occurs to cleaned surface from weather or other exposure. Where paint would be detrimental to field welding operations, surface shall not be shop painted within a suitable distance from edges to be welded.

Metal surfaces to be encased in concrete shall be painted with 1 prime coat. Painting of aluminum surfaces will not be required.

(b) **Erection Marks:** Erection marks shall be painted on surfaces with a compatible paint of contrasting color.

(c) **Inaccessible Surfaces:** Surfaces not to be in contact, but which will be inaccessible after assembly or erection, shall receive complete paint system prior to assembly or erection.

(d) **Machine Finished Surfaces:** With the exception of abutting chord and column splices, rocker shoes and bases, and column and truss shoe bases, machine finished surfaces shall be given a protective coating as soon as practical after being accepted and before removal from shop. Surfaces of iron and steel castings which are machine finished to remove scales, fins, blisters or other surface deformations shall be painted with specified paint system.

(e) **Pins and Pin Holes:** Pins and pin holes shall be given a protective coating, which shall be removed and replaced with a graphitecoating prior to erection.

(f) **3-Coat Organic Zinc Primer and Topcoat System:** Minimum dry film thickness of coatings shall be as follows:

1st Prime Coat (Tinted Red)	3 mils
2nd Prime Coat (Tinted Green)	2 mils
Vinyl Aluminum Topcoat	2 mils

Paint shall be applied in a fine, even spray with airless or conventional spray equipment. On surfaces inaccessible to spray equipment, paint shall be applied with brushes or daubers.

(1) **Primer:** Primer for new steel shall be applied after fabrication and 2 prime coats shall be applied at shop.

Each prime coat shall be cured at least 3 days before next coat is applied. Maximum time between application of coats shall be 7 days.

Potlife of primer shall not exceed limits specified by manufacturer. When limit is reached, spray pot must be emptied, material discarded, and new material mixed.

Before application of subsequent coats, surfaces shall be cleaned of dirt or other residue.

(2) **Field Spot Painting:** Damaged areas and other surfaces to be field spot painted shall be blast cleaned and given 1 coat of primer at a minimum dry film thickness of 5 mils. Primer shall be allowed to cure at least 3 days, after which topcoat shall be applied to a minimum dry film thickness of 2 mils.

(3) **Topcoat:** Topcoat paint for new steel or iron may be applied in either shop or field. Surfaces shall be cleaned of dust or other residue prior to paint application.

(g) **Coal Tar Epoxy-Polyamide System:** Minimum dry film thickness of coatings shall be as follows:

1st Coat	8 mils
Final Coat	8 mils

Coal tar epoxy-polyamide paint shall be applied in accordance with the manufacturer's recommendations.

908-7.2 Timber and Lumber: Paint shall be applied in accordance with manufacturer's recommendations. Timber and lumber shall be given 3 coats of specified or approved paint.

908-7.3 Concrete and Masonry: Paint shall be applied in accordance with manufacturer's recommendations. Concrete shall be given 1 coat of sealer and 2 coats of specified or approved paint.

908-8 MEASUREMENT AND PAYMENT: No measurement or direct payment will be for painting.

909-1**SECTION 909****MOBILIZATION**

909-1 DESCRIPTION: This work consists of preparatory work and operations, including those necessary for movement of personnel, equipment, supplies and incidentals to the project site; the establishment of offices, buildings and other facilities necessary for work on the project; the cost of bonds and any required insurance; and other preconstruction expenses necessary for start of the work, excluding the cost of construction materials.

909-2 PAYMENT:

(a) When the contract does not include a pay item for mobilization, no direct payment will be made for mobilization.

(b) When the contract contains a pay item for mobilization, payment will be made at the contract lump sum price, subject to the following provisions:

Partial payments for mobilization will be made in accordance with the following schedule up to 10% of the original total contract amount, including this item. Payment of any remaining amount will be made upon completion of all work under the contract.

<u>% of Total Contract Amount Earned</u>	<u>% of Mobilization Price to be Paid</u>
1st Partial Estimate	15
10	25
25	50
50	75
75	100

No payment adjustment will be made for this item due to changes in the work in accordance with Section 10.

909-3 PAY ITEM:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9090100	Mobilization	Lump Sum

SECTION 910**RAILROAD GRADE CROSSINGS**

910-1 DESCRIPTION: This work consists of furnishing and constructing, or removing and reconstructing, railroad grade crossings.

910-2 MATERIALS: Materials shall conform to Section 1023.

910-3 CONSTRUCTION:

(a) **General:** Grade of tracks and crossing pads may be a maximum of 1 1/2" above finished grade to provide for settling under traffic. Temporary asphalt concrete ramps shall be placed for traffic until settling of crossing has stabilized. Asphalt concrete ramps shall then be removed to provide a smooth surface through the grade crossing.

(b) **Removing Track Structure:** Existing track structure shall be removed as necessary to accommodate the new crossing. Removed materials shall be disposed of as directed.

(c) **Subbase:** The subbase shall consist of soil cement, asphalt concrete, or portland cement concrete with calcium chloride additive.

(1) **Soil Cement:** Soil cement shall be constructed in accordance with Section 304.

(2) **Asphalt Concrete:** Asphalt concrete shall be constructed in accordance with Section 501. Spreading, finishing and compaction of asphalt concrete shall be such that the surface of the mixture after compaction is smooth and meets slope and profile requirements.

(3) **Portland Cement Concrete:** Portland cement concrete shall be Class 5.5B3800 with calcium chloride added to the mix in the amount of 1 lb of calcium chloride per sack of cement at air temperatures of 70°F and above, or 2 lb of calcium chloride per sack of cement at air temperatures between 40 and 70°F. Concrete shall be placed, shaped, consolidated and cured as directed.

(d) **Underdrains:** Underdrains shall consist of 16-gage perforated bituminous coated corrugated steel pipe (6" or 8") wrapped with geotextile fabric or french drains consisting of ballast wrapped with geotextile fabric. Underdrains shall be placed on completed subbase prior to or during placement of ballast.

(e) **Ballast:** Geotextile fabric shall be placed on the completed subbase prior to placing ballast. Ballast shall be placed and satisfactorily compacted.

(f) **Track Structure:** The track structure (ties, tie plates, spikes, rail anchors, joint bars, etc.) shall be placed in accordance with **AREA** specifications.

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(g) **Crossing Units:** Units shall be installed in accordance with the manufacturer's recommendations. Bored holes in timber units shall be filled with creosote before lag screws are placed.

(h) **Asphalt Filler:** Asphalt filler material shall be hot or cold asphalt mixture acceptable to the engineer. The material shall be satisfactorily compacted and the finished surface shall be level with pavement surface.

910-4 MEASUREMENT: Railroad grade crossings will be measured on a lump sum basis.

910-5 PAYMENT: Payment for railroad grade crossings will be made at the contract lump sum price, which includes removing and disposing of the existing crossing materials, and furnishing and constructing the new crossing.

910-6 PAY ITEM:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9100000	Railroad Crossing	Lump Sum
9100100	Remove and Replace Railroad Crossing	Lump Sum

SECTION 911

FLOWABLE FILL

911-1 DESCRIPTION: This work consists of furnishing and placing a flowable fill material composed of portland cement, fly ash, sand, water and additives.

911-2 MATERIALS: Materials shall conform to the following Subsections.

Portland Cement	1002-1
Sand	1001-2.7
Water	1002-4

Fly ash and air-entraining admixtures shall be approved materials on the QPL.

911-3 PROPORTIONING: Materials shall be combined in the following approximate proportions:

Portland Cement	100 lb.
Fly Ash	300 lb.
Sand	2800 lb.
Water	50 lb.
Air-Entrainment	3-10% by vol.
Other Additives	As Needed

Proportioning of sand and water shall be adjusted as required to provide the proper consistency for placement. Fill to be pumped shall be proportioned to provide a mixture suitable for pumping through a 2" hose for at least 300 feet.

908-4 CONSTRUCTION: Mixing and hauling equipment shall conform to Section 1005.

Prior to placement of fill, structures shall be braced or anchored to protect them from displacement, and dams shall be constructed to confine the fill. Material in deep fills shall be placed in lifts and each lift shall be allowed to attain partial set before placing next lift.

911-5 MEASUREMENT: Flowable fill will be measured by the cubic yard from plant batch tickets.

911-6 PAYMENT: Payment for flowable fill will be made at the contract unit price per cubic yard.

911-7 PAY ITEMS:

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
9110000	Flowable Fill	Cubic Yard

PART X

MATERIALS

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SECTION 1001

AGGREGATES

1001-1 GENERAL: Aggregates shall be from a source listed in the QPL.

1001-1.1 Abrasion Resistance and Soundness: Maximum soundness loss of aggregate shall be 15% when subjected to 5 cycles of magnesium sulfate soundness test by AASHTO T 104. Coarse aggregates for portland cement concrete and asphalt concrete shall show an abrasion loss of not more than 40% when tested by AASHTO T 96.

1001-1.2 Deleterious Substances: Deleterious substances shall be determined in accordance with the following:

<u>Property</u>	<u>AASHTO Test Method</u>
Clay Lumps and Friable Particles	T 112
Coal & Lignite	T 113

1001-1.3 Physical Properties: Physical properties shall be determined in accordance with test methods shown:

<u>Property</u>	<u>AASHTO Test Method</u>
Clay Lumps and Friable Particles	T 19
Specific Gravity & Absorption of Course Aggregate	T 85
Specific Gravity & Absorption of Fine Aggregate	T 84
Polish Value	T 278
Amount of Material Finer than No. 200 Sieve	T 11
Sieve Analysis (Gradation)	T 27
Liquid Limit	T 89
Plasticity Index	T 90

When No. 200 sieve is included in gradation, results obtained by washing shall be added to that obtained by dry sieving.

1001-2 AGGREGATES FOR PORTLAND CEMENT CONCRETE AND MORTAR:

1001-2.1 General: When tested in accordance with ASTM C 33 Appendix XI for alkali reactivity properties. Aggregates potentially reactive with cement alkalies will be restricted to use with cement containing 0.6% or less alkalies (sodium oxide equivalent).

1001-2.2 Fine Aggregate: Fine aggregate shall be sand in which deleterious substances do not exceed the following:

<u>Property</u>	<u>Maximum %</u>
Coal and Lignite	0.25
Clay Lumps & Friable Particles	3.0

Fine aggregate subjected to colorimetric test for organic impurities (AASHTO T 21) which produces a color darker than Organic Color No. 3 shall be subjected to mortar strength test (AASHTO T 71). When subjected to mortar strength test, fine aggregate mortar shall show a minimum compressive strength of 95% of reference mortar.

Fine aggregate shall conform to the following gradation:

<u>U. S. Sieve</u>	<u>CONCRETE SAND</u>	<u>% Passing</u>
3/8"		100
No. 4		95-100
No. 16		45-90
No. 50		7-30
No. 100		0-7
No. 200		0-3

<u>U. S. Sieve</u>	<u>MORTAR SAND</u>	<u>% Passing</u>
No. 4		100
No. 8		95-100
No. 100		0-25
No. 200		0-10

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1001-2.3 Coarse Aggregate: Coarse aggregate shall be gravel, stone or crushed concrete. The amounts by weight of deleterious substances shall be as follows:

<u>Property</u>	<u>Maximum %</u>
Clay Lumps & Friable Particles	3.0
Iron Ore	2.0
Coal & Lignite	1.0 ¹

<u>Property</u>	<u>Maximum %</u>
Sticks (Wet)	0.25

¹ Aggregate used in railings shall be free from lignites.

Coarse aggregate shall conform to the following gradations:

<u>U.S. Sieve</u>	<u>Grade A</u>	<u>% Passing</u>		<u>Grade F</u>
		<u>Grade B</u>	<u>Grade D¹</u>	
2 1/2"	---	---	100	---
2"	---	100	90-100	---
1 1/2"	100	85-100	---	---
1"	90-100	---	35-80	---
3/4"	---	35-85	---	100
1/2"	25-60	---	---	90-100
No. 4	0-10	0-6	0-6	15-60
No. 8	0-5	---	---	0-15
No. 16	---	---	---	0-5
No. 20	0-1	0-1	0-1	0-1

¹ Crushed stone only.

If material finer than No. 200 sieve consists of dust from crushing, essentially free of clay, this percentage shall be 0-2. If total material passing No. 200 sieve from coarse and fine aggregates does not exceed 5%, material passing No. 200 from crushed coarse aggregate may be increased to 3%.

1001-3 BASE COURSE AGGREGATES:

1001-3.1 Sand Clay Gravel: This aggregate shall be a mixture of sand, clay and either gravel, stone or crushed concrete.

The mixture, shall be free from vegetative or other foreign matter, and shall conform to the following gradation:

<u>U. S. Sieve</u>	<u>% Passing</u>
2 1/2"	100
1 1/2"	95-100
No. 4	40-65
No. 40	20-50
No. 200	10-25

Material passing No. 40 sieve shall conform to the following:

Liquid Limit	Maximum
Plasticity Index	25
	6

1001-3.2 Stone: This material shall consist of crushed stone or crushed concrete and shall conform to the following gradation:

<u>U. S. Sieve</u>	<u>% Passing</u>
1 1/2"	100
1"	90-100
3/4"	70-100
No. 4	35-65
No. 40	12-32
No. 200	5-12

Aggregate shall have a minimum pH of 5.0, and material passing No. 40 sieve shall be nonplastic.

1001-4 SURFACE COURSE AGGREGATES:

1001-4.1 Stone: This aggregate shall consist of crushed stone or crushed concrete and shall conform to the following gradation:

<u>U. S. Sieve</u>	<u>% Passing</u>
1 1/2"	100
3/4"	50-100
No. 4	35-65
No. 40	10-32
No. 200	3-15

Aggregate shall have a minimum pH of 5.0, and material passing No. 40 sieve shall be nonplastic.

1001-4.2 Gravel: Gravel shall be free of sticks and other foreign material, and shall be graded as follows:

<u>U. S. Sieve</u>	<u>% Passing</u>
1 1/2"	95-100
No. 4	0-15
No. 200	0-2

1001-5 ASPHALT SURFACE TREATMENT AGGREGATES: Aggregates for surface treatment shall be stone, slag, expanded clay, crushed gravel or crushed concrete.

Crushed gravel shall have 60% minimum crushed retained on No. 4 sieve. These aggregates shall be graded as follows:

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<u>U. S. Sieve</u>	<u>Size 1</u>	<u>% Passing</u> <u>Size 2</u>	<u>Size 3</u>
1 1/2"	100	---	---
1"	95-100	---	---
3/4"	60-90	100	---
1/2"	---	90-100	100
3/8"	0-15	40-80	85-100
No. 4	---	15-60	0-15
No. 8	---	0-5	0-10
No. 16	---	---	0-5
No. 200	0-1	0-1	0-1

1001-6 ASPHALT CHIP SEAL AGGREGATES: Aggregates for chip seal shall be stone, slag, expanded clay, crushed gravel or crushed concrete.

Crushed gravel shall have 60% minimum crushed retained on No. 4 sieve.

Aggregates shall be graded as follows:

<u>U. S. Sieve</u>	<u>% Passing</u>
1/2"	100
3/8"	85-100
No. 4	10-40
No. 8	0-10
No. 16	0-5
No. 200	0-1

1001-7 ASPHALT CONCRETE AGGREGATES:

1001-7.1 Gravel, Stone, Slag and Crushed Concrete: The amount of clay lumps and friable particles shall not exceed 5% by weight.

1001-7.2 Coarse Sand: Coarse sand shall be free from vegetative and other foreign matter.

1001-7.3 Fine Sand: Fine sand shall be free from vegetative and other foreign matter. Fine sand shall be nonplastic with a maximum of 35% passing No. 200 sieve.

1001-7.4 Screenings: Screenings shall be made by crushing aggregates which conform to requirements for coarse aggregates in Subsection 1001-1. Screenings shall meet the following gradation requirements.

<u>U. S. Sieve</u>	<u>% Passing</u>
3/8"	100
No. 4	85-100

1001-7.5 Reclaimed Asphalt Concrete: Stockpiles of reclaimed asphalt concrete shall be

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approved prior to use. Stockpiles shall be uniform and free of soil, debris, foreign matter and other contaminants. Reclaimed material shall pass a 2" sieve.

1001-7.6 Mineral Filler: Mineral filler shall be limestone dust, pulverized hydrated lime, portland cement, or cement stack dust. Mineral dust collected in bag houses or by other dust collectors at asphalt concrete plants is not classified as mineral filler. Cement stack dust shall be material collected from waste gases discharged through a collector of a cement plant. Mineral filler shall conform to the following gradation:

<u>U. S. Sieve</u>	<u>% Passing</u>
No. 30	100
No. 80	95-100
No. 200	70-100
No. 270	60-100

1001-8 SLURRY SEAL AGGREGATES: Aggregates for slurry seals shall be stone, slag, expanded clay, crushed gravel or crushed concrete.

These aggregates shall be graded as follows:

<u>U. S. Sieve</u>	<u>% Passing</u>
3/8"	100
No. 4	85-100
No. 8	65-90
No. 16	45-70
No. 30	30-50
No. 50	18-30
No. 100	10-21
No. 200	5-15

1001-9 BEDDING MATERIAL: Bedding materials shall be a sand-aggregate mixture. Aggregate in the mixture shall be gravel, stone or crushed concrete. The mixture shall be free of foreign matter and shall be graded as follows:

<u>U. S. Sieve</u>	<u>% Passing</u>
1 1/2"	95-100
No. 4	30-50
No. 10	20-45
No. 200	0-10

1001-10 BACKFILL SAND: Sand for backfilling trenches and structures shall be nonplastic siliceous material, graded as follows:

<u>U. S. Sieve</u>	<u>% Passing</u>
1/2"	100
No. 10	75-100

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1001-11 RIPRAP: Riprap shall be crushed stone or crushed concrete. The smallest dimension shall be at least 1/3 the largest dimension. Crushed concrete shall be free of protruding steel reinforcement.

Riprap shall be graded as follows:

<u>Riprap Class</u>	<u>Stone Size Lb.</u>	<u>% of Stone Smaller Than</u>
2 lb.	10	100
	4	40-100
	2	15-50
	0.75	0-15
10 lb.	50	100
	20	50-100
	10	15-50
	5	0-15
30 lb.	140	100
	60	42-100
	30	15-50
	10	0-15
55 lb.	275	100
	110	42-100
	55	15-50
	20	0-15
130 lb.	650	100
	260	45-100
	130	15-50
	40	0-15
250 lb.	1250	100
	500	45-100
	250	15-50
	80	0-15

SECTION 1002

CEMENT, LIME AND WATER

1002-1 PORTLAND CEMENT: Portland cement shall be from a source listed in the QPL and shall conform to AASHTO M 85 with the following exceptions:

(a) Type I(B) and I(C) cement are defined as Type I cement with fineness requirements modified as follows:

	Fineness (sq m/kg)	
<u>Turbidimeter Test</u>	<u>Type I(B)</u>	<u>Type I(C)</u>
Average value, max.	200	255
Max. value, any 1 sample	210	265
<u>Air Permeability Test</u>		
Average value, max.	360	460
Max. value, any 1 sample	380	480

(b) Alkali content, calculated as sodium oxide equivalent, shall not exceed 0.6% by weight for all types of cement.

1002-2 MASONRY CEMENT: Masonry cement shall conform to ASTM C 91.

1002-3 LIME: Lime shall be hydrated lime or quicklime from a source listed in the QPL or blended lime.

(a) Hydrated Lime shall conform to ASTM C 207, Type S, except that maximum free moisture shall be 1.5%.

(b) Quicklime shall conform to the following chemical requirements:

Minimum CaO + MgO:	90% by weight of total material
Maximum MgO:	8% by weight of total material

Quicklime shall be protected from contact with moisture prior to testing, shall be free flowing and shall be graded so that 100% will pass a 3/8" sieve. When quicklime is used in a slurry the gradation shall be a minimum of 95% passing the 3/4" sieve.

(c) Blended Lime: Blended lime shall contain at least 68% calcium oxide, and shall be reasonably free of deleterious substances.

1002-4 WATER: Water suitable for human consumption may be used in mixtures with portland cement or lime without testing. Water obtained from other sources, when tested by AASHTO T 26, shall meet the following requirements.

	<u>% By Weight (Max.)</u>
Alkali	0.1
Solids (Organic)	0.1
Solids (Inorganic)	0.4
Salt (NaCl)	0.5
Sugar, Oil, or Acid	0.0

SECTION 1003

ASPHALT

1003-1 ASPHALT: Asphalt shall meet the requirements given in the following Tables.

TABLE 10-1		
ASPHALT CEMENT, GRADE AC-30		
Property	Test Method	Requirement
Penetration, 77°F, 100 g, 5 s	AASHTO T 49	55+
Viscosity, 275°F, SSF	ASTM E 102	175+
Viscosity, 275°F, cSt	AASHTO T 201	350+
Viscosity, 140°F, poises	AASHTO T 202	3,000±600
Solubility, %	AASHTO T 44	99.0+
Flash Point, COC, °F	AASHTO T 48	450+
Tests on Residue:		
Viscosity, 140°F, poises	AASHTO T 202	12,000-
Ductility, 77°F, 5 cm/min, cm	AASHTO T 51	100+
Spot Test	AASHTO T 102	Neg.

TABLE 10-2			
POLYMERIZED ASPHALT CEMENT			
		Requirement	
Property	Test Method	PAC-30	PAC-40
Penetration, 77°F, 100 g 5 sec	AASHTO T 49	50+	50-75
Viscosity ¹ 140°F, poises	AASHTO T 202	3,000+	4,000+
Viscosity, 275°F, cSt	AASHTO T 201	2,000-	2,000+
Flash Point, COC, °F	AASHTO T 48	450+	450+
Solubility ² , %	AASHTO T 44	99.0+	99.0+
Force Ductility, 39°F, 5 cm/min, 30 cm elongation, lb	ASTM P 226	0.50+	---
Force Ductility, 39°F, 5 cm/min, 30 cm elongation, f ₂ /f ₁	(See Subs. 1003-2)	---	0.30+
Residue Penetration Retention, %	AASHTO T 49	50+	50+
Elastic Recovery, 77°F, 10 cm elongation, %	(See Subs. 1003-3)	40+	60+

¹ Absolute viscosity shall be run in a Modified Koppers vacuum capillary viscometer. Report viscosity at shear rate of 1 reciprocal second.

² Either the base asphalt or polymerized asphalt may be tested.

TABLE 10-3					
CUTBACK ASPHALTS					
GRADE		MC-30	MC-70	RC-70	RC-250
Property	Test Method	Requirement			
Flash Point,	AASHTO T 79	100+	100+3	---	80
Open Tag, °F					
Viscosity, SSF, 140°F	AASHTO T 72	---	5-70	35-70	125-250
Distillate % by vol of Total	AASHTO T 78				
Distillate to 680°F					
to 437°F		0-25	0-20	50+	35+
to 500°F		40-70	20-60	70+	60+
to 600°F		75-93	65-90	85+	80+
Residue from Distillation to 680°F,					
Vol % of Sample by Difference		50+	55+	55+	65+
Tests on Residue:					
Penetration 77°F, 100 g, 5 s	AASHTO T 49	120-250	120-250	80-120	80-120
Solubility,	AASHTO T 44	99.0+	99.0+	99.0+	99.0+
Ductility, 77°F, 5 cm/min, cm	AASHTO T 51	100+	100+	100+	100+

TABLE 10-4				
CATIONIC EMULSIFIED ASPHALTS				
GRADE		CMS-2	CRS-2	CSS-1h
Property	Test Method	Requirement		
Viscosity, 122°F, SSF	AASHTO T 59	100-400	50-450	---
Viscosity, 77°F, SSF	AASHTO T 59	---	---	20-100
Residue by Distillation, % by wt.	AASHTO T 59	65+	65+	57+
Oil Distillate by Volume, %	AASHTO T 59	3.0-	12.0-	---
Particle Charge	AASHTO T 59	Pos.	Pos.	Pos.
Sieve Test (Retained on No. 20), %	AASHTO T 59	0.1-	0.1-	0.1-
Settlement, 5 Days, %	AASHTO T 59	5.0-	5.0-	5.0-
Tests on Residue				
Penetration, 77°F, 100 g, 5 s	AASHTO T 49	100-250	100-250	40-90
Solubility, %	AASHTO T 44	97.5+	97.5+	97.5+
Ductility, 77°F, 5 cm/min, cm	AASHTO T 51	80+	40+	40+
Viscosity, 275°F, cSt	AASHTO T 201	175+		---

TABLE 10-5			
ANIONIC EMULSIFIED ASPHALTS			
GRADE		SS-1	CSS-1h
Property	Test Method	Requirement	
Viscosity, 77°F, SSF	AASHTO T 59	20-100	20-100
Residue by Distillation, % by wt.	AASHTO T 59	57+	57+
Sieve Test (Retained on No. 20), %	AASHTO T 59	0.1-	0.1-
Cement Mixing	AASHTO T 59	2-	2-
Settlement, 5 Days, %	AASHTO T 59	5.0-	5.0-
Tests on Residue			
Penetration, 77°F, 100 g, 5 s	AASHTO T 49	100-200	40-90
Solubility, %	AASHTO T 44	97.5+	97.5+
Ductility, 77°F, 5 cm/min, cm	AASHTO T 51	40+	40+

TABLE 10-6			
POLYMER MODIFIED EMULSIFIED ASPHALTS ¹			
GRADE		CRS-2P	SS-1P
Property	Test Method	Requirement	
Viscosity, Saybolt:	AASHTO T 59		
77°F, SSF		---	20-100
122°F, SSF		100-400	---
Storage Stability, 24 hr. %	AASHTO T 59	1-	1-
Settlement, 5 day, %	AASHTO T 59	5-	---
Classification Test	AASHTO T 59	Pass	---
Particle Charge		Pos.	---
Sieve Test, Ret. on No. 20, %	AASHTO T 59	0.1-	0.1-
Distillation:	AASHTO T 59		
Oil distillate by vol of emulsion, %		3-	---
Residue, %		65+	---
Tests on Residue: ²			
Penetration, 77°F, 100 g, 5 s	AASHTO T 49	100-200	100-200
Softening Point, Ring & Ball, °F	AASHTO T 53	38-52	---
Solubility, %	AASHTO T 44	97.5+	97.5+
Ductility:	AASHTO T 51		
77°F, cm/min, cm		125+	---
39°F, cm/min, cm		30+	---
Tensile Stress,			
39°F, 500 cm/min, 800 % elongation, kg/cm ²	ASTM D 412	2+	---
Force Ductility, f ₂ /f ₁ , 39°F, 5 cm/min	(See Subs. 1003-2)	---	0.15+
Elastic Recovery, 50°F, 20 cm elongation, 60 min, %	(See Subs. 1003-3)	---	30+

¹ The addition of latex, rubber other additives is not allowed.

² Residue for ductility, tensile stress and elastic recovery tests shall be obtained by evaporation.

TABLE 10-7		
CATIONIC EMULSIFIED PETROLEUM RESIN (EPR-1)		
Property	Test Method	Requirement
Viscosity, 77°F, SSF	AASHTO T 59	15-100
Residue by Evaporation, % by wt.	AASHTO T 59	57+
Particle Charge	AASHTO T 59	Pos.
Sieve Test, Retained on No. 20, % Settlement, 5 Days, %	AASHTO T 59	0.1-
	AASHTO T 59	5.0-

TABLE 10-8		
AEP EMULSIFIED ASPHALT		
Property	Test Method	Requirement
Viscosity, 122°F, SSF	AASHTO T 59	15-150
Residue by Distillation, % by wt.	AASHTO T 59	50+
Oil Distillate by Volume, %	AASHTO T 59	25.0-
Sieve Test, Retained on No. 20, %	AASHTO T 59	0.1-
Storage Stability, 24 h, %	AASHTO T 59	0.1-
Settlement, 5 Days, %	AASHTO T 59	5.0-
Test on Residue:		
Penetration, 77°F, 100 g, 5 s	AASHTO T 49	250+
Solubility, %	AASHTO T 44	97.5+

1003-2 FORCE DUCTILITY TEST: The force ductility test shall be performed in accordance with ASTM D 113 with the following modifications:

- (a) Temperature: 39°F
- (b) Rate of Travel: 5 cm/min.
- (c) Standard V-shaped sides for specimen mold shall be replaced by straight-sided inserts of same length, so specimen will contain a section 1 cm x 1 cm x 3 cm.
- (d) A calibrated force adapter shall be placed on one end of specimen mold so tensile force can be determined at any point during elongation.

Force ductility is defined as the force at 30 cm elongation (f_2) divided by maximum force at initial peak (f_1). Report force ductility to nearest hundredth (0.01).

1003-3 ELASTIC RECOVERY TEST: The elastic recovery test shall be conducted as follows.

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- (a) Ductilometer Temperature:
- | | |
|-------------------------------------|------|
| Polymerized Asphalt Cement | 77°F |
| Polymer Modified Emulsified Asphalt | 50°F |

(b) Procedure: Condition ductilometer and samples to be tested at temperature prescribed. Prepare brass plate, mold and briquet specimen in accordance with ASTM D 113. Standard V-shaped sides for specimen mold shall be replaced by straight-sided inserts of same length, so specimen will contain a section 1 cm x 1 cm x 3 cm. With specimen at specified test temperature, place specimen in ductilometer and immediately elongate specimen to 10 cm for Polymerized Asphalt Cement, or 20 cm for Polymer Modified Emulsified Asphalt. Rate of pull shall be 5 cm/min. For Polymerized Asphalt Cement, clip sample approximately in half immediately after reaching 10 cm elongation. For Polymer Modified Emulsified Asphalt, let sample remain in elongated position for 5 minutes after reaching 20 cm elongation, then clip sample approximately in half. Let severed sample remain undisturbed in ductilometer for 1 hour, then move traveling carriage back to a position where severed ends of specimen touch. Observe and record elongation of specimen with severed ends just touching.

- (c) Calculation: Calculate percent recovery by the following formulas:

Polymerized Asphalt Cement

$$\% \text{ Recovery} = \frac{10 - a}{10} \times 100$$

Polymer Modified Emulsified Asphalt

$$\% \text{ Recovery} = \frac{20 - a}{20} \times 100$$

Where:

a = observed elongation after rejoining of sample, cm.

1003-4 ASPHALT ADDITIVES: Anti-strip and silicone additives shall be approved products on the QPL.

SECTION 1004

ASPHALT CONCRETE

1004-1 GENERAL: Asphalt concrete shall consist of aggregates and asphalt combined in a central plant and meeting requirements of Table 10-10. Mix types shall be used as follows:

Arterial Roads & Streets	Type A Wearing Course
	Type B Binder Course
	Type B Base Course
Collector Roads & Streets	Type B Mixtures
Local Roads & Streets, Parking Areas, Islands, Etc.	Type C Mixtures

1004-2 MATERIALS: Accurate records shall be kept, including proof of deliveries of materials for use in asphalt concrete. Copies of these records shall be furnished to the engineer upon request. Materials shall conform to the following Subsections:

Asphalt	1003-1
Additives	1003-4
Aggregates	1001-7
Hydrated Lime	1002-3

(a) **Asphalt:** Asphalt cement used in mixtures shall be as follows:

When "Polymerized Asphalt Concrete" is specified, only polymerized asphalt shall be used in the mix. When "Asphalt Concrete" is specified, either polymerized or non-polymerized asphalt may be used in the mix.

Asphalt Concrete:	
Type A Mix	Grade AC-30 or PAC-40
Type B or C Mix	Grade AC-30 or PAC-30
Polymerized Asphalt Concrete:	
Type A Mix	Grade PAC-40
Type B or C Mix	Grade PAC-30

(b) **Additives:**

(1) **Anti-Strip:** An anti-strip additive shall be added at the minimum rate of 0.5% by weight of asphalt and mixed with asphalt cement at the plant. Additional anti-strip additive shall be added in accordance with Subsection 1004-4(b).

(2) **Silicone:** Silicone additives, when needed, shall be dispersed into asphalt by methods and in concentrations given in the QPL.

(3) **Hydrated Lime:** Hydrated lime may be incorporated into asphalt concrete mixtures at the rate specified in the approved job mix formula. Minimum rate shall be 1.5% by weight of

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total mixture. Hydrated lime shall be mixed with aggregates prior to mixing with asphalt.

(c) **Aggregates**

(1) **Crushed Concrete:** Crushed concrete may be used in mixtures up to 70% by weight of aggregates. Crushed concrete shall be stockpiled separate from other aggregates at the plant.

(2) **Reclaimed Asphalt Concrete:** Reclaimed asphalt concrete may be used in mixtures up to 20% by weight of aggregate. Reclaimed asphalt concrete shall contain no expanded clay aggregate and shall be stockpiled separate from other aggregates at the plant.

A separate cold feed system shall be provided for reclaimed asphalt concrete, and new aggregates shall be heated to a sufficiently high temperature to produce a mix at required discharge temperature.

1004-3 EQUIPMENT: Plant and hauling equipment shall be DOTD certified.

1004-4 **MIX DESIGN AND CONTROL:**

(a) **General:** The contractor shall be responsible for design, production and hauling of mixtures, and shall constantly monitor equipment, materials and processes to ensure that mixtures are produced in accordance with specifications. If specifications are not being met and satisfactory control adjustments are not being made, operations shall be discontinued until proper adjustments and uniform operations are established.

The contractor shall conduct tests as necessary, in addition to required tests, to produce mixtures within specifications.

When the plant is in operation, the contractor shall have a DOTD Certified Asphalt Concrete Technician at the plant or jobsite who is capable of designing asphalt concrete mixes, conducting any test or analysis necessary to put the plant into operation and producing a mix meeting specifications. Daily plant operations shall not begin unless the Certified Asphalt Concrete Technician is at the plant.

(b) **Job Mix Formula:** The contractor shall design mixtures in accordance with DOTD TR 303, Method A; however, Method B may be used when approved. The job mix formula shall include the recommended formula and supporting design data. The recommended formula shall be submitted for approval to the engineer. No mixture shall be produced until the proposed job mix formula has been approved.

The proposed job mix formula shall indicate a single anti-strip additive rate which is 0.1% greater than the percentage which will yield a minimum of 90% coating when tested by DOTD TR 317, but not more than 1.2% by weight of asphalt.

The job mix formula shall indicate a single rate of hydrated lime additive when used. Hydrated lime additive shall not be less than 1.5% by weight of total mixture.

The job mix formula shall produce a mixture with a minimum Tensile Strength Ratio (TSR) of 75% when tested by DOTD TR 322.

The job mix formula shall indicate optimum mixing temperature. When aggregates with a water absorption value greater than 2%, determined by AASHTO T 84 for fine aggregate and AASHTO T 85 for coarse aggregate, or aggregates with an asphalt absorption value greater than 0.5%, determined by DOTD TR 320, are used, initial optimum asphalt content shall be increased to compensate for asphalt absorbed by aggregates.

1004-5 HANDLING OF AGGREGATES: Aggregates shall be stored at the plant so that no intermixing will occur. Material shall be stockpiled so that no detrimental degradation or segregation of aggregates will occur, no foreign material will be incorporated into aggregates, and there will be no intermingling of materials. Stockpiles shall be well drained.

Blending of aggregates shall be done from cold feed bins and not in stockpiles or on the ground.

Gradation and other properties of aggregate in stockpiles shall be such that when aggregates are combined in proper proportions, the combined gradation will conform to the approved job mix formula.

Proportioning of material at the cold feed shall be established to meet the approved job mix gradation requirements. Plants operating with only cold feed control shall not require additional manipulation to meet job mix requirements.

(a) **Drying:** Aggregates shall be heated and dried to produce a mixture meeting specifications. Material fed through dryer shall be held to an amount which can be adequately heated and dried. When proper drying is not achieved and quality of the mix is impaired, production rate of dryer shall be adjusted to obtain satisfactory results. Burner fuel used shall be clean burning so there is no contamination of aggregates.

(b) **Hot Aggregate Storage:** In batch plants, hot aggregate shall be so stored in bins as to minimize segregation and loss of temperature of aggregates. When plant operation is interrupted and material in storage cools to 25°F or more below specified mixing temperature, aggregate in bins shall be discarded. When a plant changes type of mix that requires a change of materials, aggregate in bins shall be discarded.

1004-6 PROCESSING OF ASPHALT AND AGGREGATES: Aggregates shall be combined to meet the approved job mix formula.

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Maximum moisture content of final mixture shall be 0.5% by weight when tested by DOTD TR 319.

When automatic adjustments or other critical control devices are not functioning, the plant shall not operate.

(a) **Plants with Pugmills:** Combined aggregate shall be mixed dry, after which asphalt shall be sprayed over aggregates and mixed to produce a mixture in which aggregate particles are uniformly coated. Mixing times shall be in accordance with the approved job mix formula.

(b) **Drum-mixer and Continuous Mix Plants:** The system shall provide positive weight control of cold aggregates fed by a belt scale or other device interlocked with the asphalt measuring system to maintain required proportions of combined aggregates and asphalt. Aggregates shall be heated, dried and mixed with asphalt to produce a mixture in which aggregate particles are uniformly coated. The first and last output of the plant shall be wasted after each interruption.

The Certified Asphalt Concrete Plant Technician shall measure moisture content of cold feed aggregates daily when starting the plant. Adequate scheduled tests during plant operations and adjustments to the plant shall be made to correct for moisture in the aggregate.

Provisions shall be made for introducing the latest moisture content of cold feed aggregates into belt weighing system, thereby correcting wet aggregate weight to dry aggregate weight. Dry weight of aggregate flow shall be displayed digitally in units of weight and time, and the quantity totaled. The rate of flow of asphalt anti-strip and lime (when used) shall also be digitally displayed and the quantity totaled.

For mineral filler, a separate bin and feeder shall be furnished with its drive interlocked with aggregate feeders. Mineral filler shall be introduced into drum near asphalt discharge.

(c) **Scales and Printer Systems:**

(1) **Scales:** To determine the total weight of mix loaded in trucks, springless dial scales or load cell scales for weigh hoppers shall be provided. When weigh hoppers are not used, truck platform scales shall be provided. When drum-mixer process is used, belt scales shall be provided for conveyors.

(2) **Printer System for Batch Plants:** An approved printer system shall be provided which will print separately the weight of aggregates and asphalt. These weights shall be used for calculating percent asphalt in the mixture. When a mixture is loaded directly into haul truck, these weights shall be used to determine pay weights for the mix. Printing equipment shall also print zero weight for each batch and total weight of mixture loaded in trucks.

In case of a printing mechanism breakdown, the plant will be permitted to operate during the 48-hour period immediately following the breakdown, provided an accurate weight of mixture can be determined and repeated breakdowns do not occur.

(3) **Printer System for Plants With Storage or Surge Bins:** When storage or surge bins are used, truck-platform scales or a weigh hopper shall be provided to determine pay weights for the mix. The weigh hopper shall be equipped with an approved automatic printer system that will print zero weight, batch weight and total weight of mixture loaded into truck.

Truck-platform scales shall be of sufficient length to weigh the entire unit transporting the mix. Scales shall be equipped with an approved automatic printer system that will print tare weight and total weight of unit and mix.

Scales with electronic digital readout displays, that do not automatically reset to zero after tare weight is obtained, shall print tare weight, zero weight, and either total weight of mix loaded into unit or total weight of unit and mixture. Scales with electronic digital readout displays that automatically return to zero after tare weight is obtained shall print tare weight and either total weight of mix loaded into unit or total weight of unit and mixture.

When scales are located so that a truck leaves the scales between empty weighing and loaded weighing, printer shall print tare weight, zero weight before loaded weighing, and total weight of unit and mix. In case of a printing mechanism breakdown, the plant will be permitted to operate during the 48-hour period immediately following the breakdown provided an accurate weight of mixture can be determined and repeated breakdowns do not occur.

1004-7 STORAGE SILOS AND SURGE BINS: Storage silos or surge bins for storing asphalt concrete mixtures may be used.

(a) **Conditions of Use:** Use of silos or bins shall conform to specification limitations on retention time, type of mixture, heater operation, bin atmosphere, bin level or other characteristics.

An indicator which is activated when material in bin drops below top of sloped portion shall be affixed to each bin and be visible to operator. Mixtures shall be maintained above this level during production.

(b) **Heated Silos:** Storage silo heating system shall be capable of maintaining mix temperature without localized heating.

Maximum allowable storage time for asphalt concrete mixtures is 18 hours unless test results and other data indicate that additional storage time is not detrimental to mix.

(c) **Unheated Surge Bins:** Maximum allowable storage time for unheated surge bins is 2 hours unless test results and other data indicate that additional storage time is not detrimental to mix.

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(d) **Loading and Unloading Mixtures:** Mixtures shall be conveyed from plant to bin or silo by an enclosed continuous system designed to prevent spillage and to remove mix from plant as fast as it is produced. Mixture in silo or surge bin shall remain within $\pm 15^{\circ}\text{F}$ of plant discharge temperature.

When mixture is placed in silo or bin through a surge device, an automatic warning system shall be provided to audibly warn operator of a gate malfunction.

Silo or bin unloading gates shall be of a type that will not cause segregation or be detrimental to mix.

TABLE 10-9								
ASPHALT CONCRETE MIXTURES								
U.S. SIEVE % PASSING	TYPE A	TYPE B			TYPE C			MIX TOLERANCE
	Wearing Course	Wearing Course	Binder Course	Base Course	Wearing Course	Binder Course	Base Course	
1½"	---	---	---	100	---	Same	Same	---
1"	100	---	100	80-100	---	Gradation	Gradation	±6
¾"	95-100	100	85-100	---	---	As Type B	As Type B	±6
½"	80-95	90-100	70-100	---	100	Binder	Base	±6
⅜"	70-88	70-100	60-95	---	90-100	Course	Course	±6
No. 4	50-75	50-75	40-70	35-70	55-85			±6
No. 10	28-55	28-55	28-50	---	30-65			±6
No. 40	14-30	14-30	14-30	16-40	14-30			±5
No. 80	8-20	8-20	8-20	---	8-20			±4
No. 200	3-8	3-8	3-8	3-8	3-8			±2
Extracted Asphalt	---	---	---	---	---			±0.4
Mixing Temperature ¹	---	---	---	---	---			±25°F
% Crushed, min. ²	90	85	As Needed	As Needed	80	As Needed	As Needed	---
Marshall Stability, lb								
No. of Blows	75	75	75	75	50	50	50	
Av. of 4 Tests:								
Design	2000	1700	1700	1400	1200	1200	1100	
Minimum	1800	1500	1500	1200	1000	1000	900	
Individual Test, min.	1500	1300	1300	1000	800	800	80	
Marshall Flow, 1/100"	6-15	6-15	5-15	15 Max.	8-18	8-15	15 Max.	
% Voids	3-5	3-5	3-5	3-5	2-4	3-5	3-5	
% VFA	70-80	70-80	70-80	70-80	75-85	70-80	70-80	

¹ Determined by Job Mix Formula.

² Determined by DOTD TR 306.

SECTION 1005

PORTLAND CEMENT CONCRETE

1005-1 GENERAL: Portland cement concrete shall consist of aggregates, portland cement and water combined to meet requirements of Table 10-11.

Mix types shall be used as follows:

<u>Class</u>	<u>Use</u>
5B3000	Base course
5.5B3800 or 5.25D3800	Pavements, walks, drives, revetments, curbs, etc.
6A4000	Structural concrete (except bridge superstructures)
7F4000	When specified or permitted
6.5A4200	Bridge superstructures
7A4400	Underwater concreting
6.5A5000	Prestressed concrete piles and girders
4A1800 or 4B1800	Sacked concrete

1005-2 MATERIALS: Materials shall conform to the following Subsections:

Portland Cement	1002-1
Aggregates	1001-2
Admixtures	1008-2
Water	1002-4

1005-3 HANDLING AND STORAGE OF CEMENT: Cement shall be transported in watertight conveyances and stored in silos or other approved facilities so that cement will be protected from dampness or water intrusion. Material which has become contaminated, partially set or containing lumps of caked cement shall not be used. When bagged cement is permitted, handling and storage shall be as directed.

Different brands or types, or the same brand or type from different mills, shall not be mixed or used alternately. This requirement may be waived in case of plant breakdown during production to allow concrete to be furnished from another plant to finish placement in progress.

1005-4 HANDLING AND STORAGE OF AGGREGATES: Equipment and methods for stockpiling aggregates shall be such that no detrimental degradation or segregation of aggregate will result, no appreciable amount of foreign material will be incorporated into aggregate, and there will be no intermingling of materials.

Stockpiles of aggregates shall be well drained and shall have uniform moisture content.

Material shall not be added to working faces of stockpiles during operations.

Different grades and types of aggregates shall be stored in separate stockpiles.

Aggregates shall be handled from stockpiles or other sources to the batch plant so as to secure uniform grading of material. Aggregates that have become segregated or contaminated shall not be used. Aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or placed in bins for drainage. Transport containers may be used as bins when drainage is provided. Coarse aggregates in stockpiles that have dried to the extent that aggregates absorb mixing water shall be saturated with water.

1005-5 QUALITY CONTROL OF CONCRETE: The contractor shall be responsible for quality control of materials, for initial determination and necessary subsequent adjustments in proportioning of materials, and for providing suitable equipment for determination of aggregate gradation, moisture, air content, slump, temperature, and trial mixes as necessary. Testing and analysis of the mix for quality control, the setting of dials, gages, scales or meters, adjusting batch weights, and accurate batching shall be the responsibility of the contractor.

The contractor shall provide the following DOTD certified personnel: Authorized Concrete Batchers, Authorized Concrete Field Testers, and Certified Concrete Technicians. An Authorized Concrete Batchers shall perform batching operations. A Certified Concrete Technician shall be present at plant or jobsite when plant is in operation. Daily plant operations shall not begin unless the Authorized Concrete Batchers or Certified Concrete Technician is at the plant. Tests for gradation, moisture and adjusted batch weights shall be completed and shall be within specification limits before batching.

The Certified Concrete Technician shall design concrete mixes, make adjustments in batch weights for moisture content, perform necessary adjustments in proportioning of materials, and shall perform tests necessary for control of the mix within specification requirements. If a Certified Concrete Technician is not available at the jobsite, an Authorized Concrete Field Tester will be allowed to perform control tests for slump and report results to the Certified Concrete Technician. The use of an Authorized Concrete Field Tester will not relieve the Certified Concrete Technician from performing the remaining duties as outlined in these specifications.

(a) **Mix Design:** When requested, the contractor shall submit a proposed mix design giving intended sources of materials and mix design for concrete to be furnished. No concrete shall be produced until the mix design has been approved.

When unusual materials necessitate tests on trial mixes, the contractor shall conduct trial mixes and submit test results for slump, air content and 28-day compressive strength.

(b) **Quality Control Tests:** The contractor shall be responsible for determining gradation and moisture content of aggregates used and

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for testing the mixture at the jobsite for slump and temperature. The mix produced shall conform to the approved mix design, except that variations will be permitted within specified control limits for individual samples.

(c) **Mix Adjustments:** The contractor may vary the ratio of fine to coarse aggregate, but in no case shall it be varied so as to materially affect the specified cement factor.

The mix produced shall be uniform and within specification limits.

When slump, mix temperature, or gradation measurements indicates that the mix may fall outside tolerance limits, the contractor shall immediately make adjustments to keep the mix within specified limits.

1005-6 COMPOSITION OF CONCRETE:

(a) **Cement:** Allowable types of cement are as follows:

	<u>Cement Types</u>
Cast-in-Place Concrete (Non-Prestressed)	Type I, I(B) or II
Prestressed or Precast Concrete	Type I, I(B), I(C), II or III

(b) **Admixtures:** When approved, a water-reducing admixture may be used; however, no air-entraining admixture or fly ash will be permitted.

When air temperature is above 70°F, water-reducing admixture shall be the set-retarding type; when air temperature is 70°F or below, water-reducing admixture shall be the normal set type.

(c) **Water:**

Free water shall include all water entering the mix with aggregate, except water absorbed by aggregate.

(d) **Aggregate:** Coarse aggregate shall be the grade specified in Table 10-11.

(e) **Slump:** Mixtures shall have slumps within the ranges shown in Table 10-11 when tested by AASHTO T 119. The engineer may authorize an increase in maximum slump for concrete in walls and diaphragms less than 8" thick.

(f) **Compressive Strength:** Concrete mixtures shall provide compressive strengths not less than as specified in Table 10-11.

1005-7 EQUIPMENT:

(a) Concrete plant and hauling equipment shall be DOTD certified. Sufficient plant capacity and transporting equipment to ensure delivery at required rate shall be provided. Rate of concrete delivery shall provide for proper handling, placing and finishing of concrete and maintain a workable surface. Methods of

delivering and handling concrete shall facilitate placing with a minimum of rehandling and without damage to structure or concrete.

(b) **Plant Equipment:** Materials shall be incorporated into mix by methods which will ensure uniform distribution. The amount of each material used in mix shall be recorded and certified by the Authorized Concrete Batchers or Certified Concrete Technician.

(1) **Measuring Devices:** Materials shall be measured by weighing except where other methods are authorized.

Fine aggregate and each size of coarse aggregate shall be weighed on scales, separately or cumulatively, in weigh hopper from separate bins. If cement is used in bulk, a separate scale system shall be used.

Batch plants may be equipped to proportion materials by automatic weighing devices.

Provisions shall be made for removal of overload from hopper by operator.

Individual aggregates shall be batched within 2%, and total weight of aggregate shall be within 1% of required weight.

Cement shall be within 1% of required weight. Cement in standard bags need not be weighed; however, when bag cement is used, quantities of aggregates for each batch shall be sufficient for 1 or more full bags of cement.

Mixing water shall be measured by volume or weight. Quantity of admixtures shall be measured within \pm 3%. Admixtures shall be mechanically dispensed in a liquid state with mixing water. A separate dispensing device shall be provided for each mixture.

(2) **Ticket Printer System:** When an automatic ticket printer system is used, it shall be tamper-proof and shall print time of batching, amount of water, batch weights, moisture content of aggregate, and quantities of admixtures. Moisture content of aggregate or quantities of admixtures may be added to printed ticket by the Authorized Concrete Batchers or Certified Concrete Technician when automatic system does not have these capabilities. During a breakdown, quantities shall be determined by visual observation and certified as stated above.

When an automatic ticket printer system is not used, quantities and batching information shall be determined by visual observation, recorded, and certified correct by the Authorized Concrete Batchers or Certified Concrete Technician.

Records of batches shall show batch number, day, month, year, and time of day to the nearest minute. Maximum quantity of water that can be added at jobsite shall be shown on batch ticket. The engineer shall be provided with a copy of batch records identified with lot number and mix design number.

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(c) **Hauling Equipment:** Hauling equipment shall be watertight and capable of discharging concrete at a controlled rate without segregation.

(1) **Truck Mixer:** Truck mixer shall be revolving drum type, equipped with pressurized, calibrated tanks for carrying a portion of mixing water.

Only the prescribed amount of water shall be placed in tank unless tank is equipped with a device by which quantity of water added can be verified.

Truck mixers shall have electrically or mechanically actuated revolution counters by which number of revolutions may be verified.

Truck mixer shall have attached thereto a metal plate on which is marked uses for which equipment is designed, maximum rated capacity of drum in terms of concrete volume, and rotation speed for both agitating and mixing speeds.

Truck mixers shall be equipped with means for accurately measuring amount of water used in each batch.

(2) **Agitator Hauling Equipment:** Agitators shall have blades or paddles to agitate mix and prevent segregation. Covers shall be provided when directed.

Agitator shall have attached thereto a metal plate on which is marked uses for which equipment is designed, maximum rated capacity in terms of concrete volume, and agitation speed.

(3) **Non-Agitator Hauling Equipment:** Bodies of nonagitating hauling equipment shall be smooth, mortartight, metal containers. Covers shall be provided when directed.

(d) **Portable Mixers:** Portable mixers shall have minimum capacity of 1 cubic yard and be capable of uniformly mixing and discharging concrete without segregation.

1005-8 BATCHING AND MIXING:

(a) **General:** Concrete shall be mixed in a mixer of a type which will ensure uniform distribution of materials.

Pick-up and throw-over blades or mixing paddles in mixing unit shall be replaced when worn beyond limit recommended by manufacturer. The contractor shall have available a copy of manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth.

Mixing operations shall begin within 30 minutes after cement is added to aggregate. When cement is charged into a mixer drum containing surface-wet aggregate and air temperature is over 90°F, or when high

early strength cement is used, this limit shall be reduced to 15 minutes. When mixing operations are interrupted, mixer shall be cleaned. Contents of mixer shall be removed from drum before materials for a succeeding batch are placed therein. Materials composing a batch shall be deposited simultaneously in an operating mixer. A portion of mixing water shall enter in advance of cement and aggregates. No mixer having a rated capacity of less than 1 cubic yard shall be used nor shall a mixer be charged in excess of its rated capacity. Minimum size batch shall be 1 cubic yard.

Temperature of concrete mixture shall not exceed 90°F.

(b) **Central Plant and Site Mixing:** Concrete shall be mixed for at least 50 seconds. Mixer shall have a timing device which will automatically lock discharge lever when drum has been charged and release it at end of mixing period. Mixer shall be operated at a drum speed for which it has been designed as shown on manufacturer's name plate on mixer.

(c) **Truck Mixing:** Aggregates and cement shall be measured and charged into drum at proportioning plant.

Size of batch in truck mixers shall not exceed capacity of mixer as stated by manufacturer and stamped on a metal plate on mixer. When a truck mixer is used for complete mixing, each batch shall be mixed for 70 to 130 drum revolutions at rate of rotation designated as mixing speed by manufacturer. Any additional mixing shall be at agitating speed. All materials, including mixing water, shall be in mixer drum before actuating revolution counter or taking initial reading.

When prescribed amount of water is added at batch plant and slump is on the low side at jobsite, it will be permissible to add a minimum of 75% of mixing water at batch plant and remaining mixing water at jobsite. Water added at jobsite may be added in 1 or 2 increments with additional mixing of 20 to 30 revolutions at designated mixer speed for each increment; however, total of 130 revolutions shall not be exceeded.

(d) **Partial Mixing at Central Plant:** When partial mixing is allowed at a central plant, mixing time at plant may be reduced to 30 seconds. Mixing shall be completed in a truck mixer at mixing speed. Mixing time in truck mixer shall be 10 to 70 revolutions.

(e) **Time Limitations:** Maximum time from addition of cement to mix to complete discharge of concrete shall be 90 minutes when transport is by truck mixer or agitator. Maximum time from addition of cement to mix to complete discharge of concrete shall be 45 minutes when transport is by non-agitator truck. In hot weather maximum time may be reduced by the engineer.

(f) **Hauling Equipment:** Wet batches of concrete may be transported in a truck mixer, agitator or other approved equipment. Maximum volume of mixed concrete transported in an agitator and agitation speed shall be in accordance with manufacturer's rating.

TABLE 10-11
PORTLAND CEMENT CONCRETE MIXTURES

Class	Min. Cement Content 94-lb Bags/C.Y.	Min. 28-day Compressive Strength, psi	Coarse Aggregate Grade	Slump (inches)	
					Slip- Formed
5B3000	5.0	3000	B	2-5	1-2
5.5B3800	5.5	3800	B	2-5	1-2
5.25D3800	5.25	3800	D	2-5	1-2
6A4000	6.0	4000	A	2-5	---
7F4000	7.0	4000	F	2-6	---
6.5A4200	6.5	4200	A	2-5	---
7A4400	7.0	4400	A	6-8	---
6.5A5000	6.5	5000	A	2-6	---
4A1800	4.0	1800	A	2-5	---
4B1800	4.0	1800	B	2-5	---

SECTION 1006**REINFORCING STEEL**

1006-1 REINFORCING STEEL: Reinforcing steel for bridges shall be Grade 60; in other structures, deformed bars No. 3 thru No. 6 shall be Grade 40 or 60; No. 7 and larger shall be Grade 60. No. 2 bars need not be deformed. Deformed bars shall conform to Headings (a), (b) or (c) below. Wire conforming to Heading (d) below may be used in lieu of No. 2 bars when furnished in size W 5.

(a) Billet-Steel Bars shall conform to ASTM A615.

(b) Rail-Steel Bars shall conform to ASTM A 616.

(c) Axle-Steel Bars shall conform to ASTM A 617.

(d) Cold-Drawn Steel wire shall conform to ASTM A 82 with the following amendment: For material testing over 110,000 psi tensile strength in high strength applications such as spirals and ties, the 25% minimum reduction in area shall be reduced 5% for each 10,000 psi increment of tensile strength exceeding 110,000 psi.

(e) Welded Steel Wire Fabric shall conform to ASTM A 185.

(f) Epoxy Coated Reinforcing Steel shall conform to AASHTO M 284 and shall be a product listed on the QPL.

1006-2 SPIRAL REINFORCING: Spiral reinforcing shall conform to Subsection 1006-1 (a), (b), (c) or (d).

1006-3 TIE BARS: Tie bars shall conform to Subsection 1006-1 (a), (b) or (c). Tie bars to be bent and restraightened during construction shall be Grade 40.

1006-4 DOWEL BARS: Dowel bars shall be plain steel bars conforming to Subsection 1006-1 (a), (b) or (c). Dowels shall have a uniformly round cross section and shall be saw cut, smooth and free of burrs and projections.

Dowel bars shall be plastic coated in accordance with AASHTO M 254, Type A.

1006-5 STEEL STRAND FOR PRETENSIONING: Strand for pretensioning shall conform to ASTM A 416.

1006-6 BARS FOR POST-TENSIONING: Bars shall be steel conforming to ASTM A 722 having a minimum modulus of elasticity of 25,000,000 psi, and shall be equipped with wedge-type end anchorages which will develop minimum specified ultimate bar stress on nominal bar area.

1006-7 PARALLEL WIRE ASSEMBLIES FOR POST-TENSIONING: Assemblies shall consist of parallel wire of specified number and size Wire shall be high tensile strength, hard-drawn, stress-relieved and uncoated. Wire shall conform to ASTM A 421, Type WA.

1007-1**SECTION 1007****JOINT MATERIALS****1007-1 PREFORMED JOINT FILLERS:**

(a) **Preformed Resilient Bituminous Type:** Fillers shall consist of preformed strips made of cane or other cellular fibers bound together and saturated with asphalt or strips formed from granulated cork bound together by an asphalt binder and encased between 2 layers of saturated or glass-fiber felt.

(b) **Wood Fillers:** Bottom boards shall be clear heart redwood. Top boards shall be any type of wood which is free of defects that will impair its usefulness.

(c) **Preformed Bituminous Type:** Bituminous preformed expansion joint filler shall consist of bituminous (asphalt or tar) mastic, formed and encased between 2 layers of bituminous impregnated felt. Preformed filler shall conform to ASTM D 994.

(d) **Preformed Asphalt Ribbon:** This filler shall consist of preformed strips of bitumen and inert filler material conforming to the following requirements:

Thickness, inches	1/8-3/16
Depth tolerance, inches	±1/8
Weight, lb/100 sq. ft., min	50
Tensile Strength, lb/inch width, min	50
Bitumen, strength, lb/inch width, min	50

Tensile strength is determined by pulling a 1" x 6" sample at a 20"/minute separation rate.

This material shall be resistant to cracking, tearing or permanent deformation under normal handling and installation procedures. It shall be sufficiently rigid to enable it to form a straight joint.

(e) **Preformed Closed Cell Polyethylene Joint Filler:** Filler shall be formed by expansion of polyethylene base resin, extruded as a multicellular, closed cell, homogeneous section of foamed polyethylene. This material shall be used with an adhesive-lubricant.

Fillers and adhesive-lubricants shall be products listed in the QPL.
Filler shall conform to the following requirements:

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Density, pcf	ASTM D 3574	1.1-3.0
Water Absorption, % by vol, max.	ASTM C 272 ¹	1.0
Compression, psi	ASTM D 1056	
@ 20% deflection, min.		3.0
@ 80% deflection, max.		125.0
Extrusion @ 80% deflection, inches, max.	ASTM D 545	0.12

¹ The requirement that materials which trap water in flutes be dipped in absolute alcohol shall be omitted. Instead, filler shall be dried by blotting with absorbent paper.

1007-2 POURED AND EXTRUDED JOINT SEALANT:

(a) **Hot Poured Rubberized Asphaltic Type:** This material shall conform to ASTM D 3405. Sealant and backer materials shall be products listed in the QPL. Backer material shall be capable of withstanding temperatures up to 410°F.

(b) **Polyurethane Sealants:** This joint system shall be a 1- or 2-component pourable or extrudable sealant with primers and backer material. It shall cure to a solid rubber-like material able to withstand both tension and compression.

Sealant with primers and backer materials shall be products listed in the QPL.

Container shall be labeled with name and type of material, batch number, manufacture date, and expiration date.

The material shall conform to the following requirements.

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Flow, inches, max.	AASHTO T 187 ¹	0.2
Tack-Free Time, h, max.	Fed. Spec. TT-S-00227	72
Bond, in. sep., max.	DOTD TR 635	0.25
Resilience, %, min.	DOTD TR 623	75
Ball Penetration	DOTD TR 623	5-20
Resilience (after heat aging) %, min.	DOTD TR 623	75
Weatherometer, 600 h, min.	DOTD TR 611	Pass
Ozone Resistance (Exposure to 100 pphm ozone for 100 h @ 104°F, sample under 20% strain or bent loop)		No Cracks
Weight loss, % max.	ASTM D 1149	10
Infrared Charts Activator	Fed. Spec. TT-S-00227	Pass
Base	DOTD TR 610	Pass

¹ Flow test will be conducted according to AASHTO T 187 except that samples shall be placed in an oven maintained at 150±2°F for 24 hours.

(c) **Silicone Sealant:** This joint system shall be an extrudable sealant and backer material with primer, if required. Silicone polymer shall cure to a solid rubber-like material able to withstand both tension and compression.

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Sealant, backer materials and primers, if required, shall be products listed in the QPL.

Container shall be labeled with name and type of material, batch number, manufacture date, and expiration date.

Sealant shall conform to Fed. Spec. TT-S-001543 for Class A Sealants as modified by the following requirements:

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Flow, inches, max.	AASHTO T 187 ¹	0.3
Tack-Free Time at 77°F and 45-55% R.H., minutes	Fed. Spec. TT-S-00227	20-75
Resilience, %, min.	ASTM D 3583 ²	60
Resilience (after heat aging) %, min.	ASTM D 3583 ² ASTM C 661 ²	60 10-25
Durometer, Shore A	ASTM D 412, Die C ²	75
Tensile Stress at 150% elongation, psi, max.	ASTM D 412, Die C ²	1000
Elongation, % min.	DOTD TR 635	0.25
Bond, inches separation, max.		

¹ Flow test will be conducted according to AASHTO T 187, except that samples shall be placed in an oven maintained at 150±2°F for 24 hours or as recommended by the manufacturer.

² Cured 7 days at 75-90°F and 45-55% relative humidity or as recommended by the manufacturer.

1007-3 PREFORMED ELASTOMERIC COMPRESSION JOINT SEALS:

(a) **Seals:** Seal shall be a product listed in the QPL.

Uncompressed seal depth shall be equal to or greater than the uncompressed seal width. Actual seal width shall not be less than nominal seal width.

(1) **Pavements:** The material shall conform to ASTM D 2628 with the following exceptions:

(a) Ozone resistance may be determined by bent loop test method.

(b) Seal shall exert a minimum pressure of 3 psi (4 psi for expansion joints) at 80% of nominal width and a maximum of 25 psi at 50% of nominal width.

(2) **Bridges:** Seal shall conform to ASTM D 3542 and shall exert a minimum pressure of 4 psi at 80% of nominal width.

(b) **Adhesive-Lubricant:** Adhesive-lubricant shall conform to ASTM D 4070 and shall be a product listed in the QPL.

1007-4 COMBINATION JOINT FORMER/SEALER: This joint former/sealer is for use in simultaneously forming and sealing a weakened plane in concrete pavements.

Material shall consist of an elastomeric strip epoxied into a toothed groove formed at top of each of 2 rigid plastic side frames or mechanically bonded at top of the 2 rigid plastic side frames and covered with a removable plastic top cap. Side frames shall be of such configuration that when sealer is inserted into plastic concrete and vibrated, a permanent bond forms between side frames and concrete.

(a) **Elastomer:** Elastomer strip portion of material shall be manufactured from vulcanized elastomeric compound using polymerized chloroprene as base polymer, and shall conform to the following requirements:

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Tensile Strength, psi, min.	ASTM D 412	1800
Elongation at Break, % min.	ASTM D 412	200
Hardness, Shore A	ASTM D 2240	65±10
Properties after Aging, 70 h @ 212°F		
Tensile Strength, % loss, max.	ASTM D 573	20
Elongation, % loss, max.		25
Hardness, pts. increase, max.		10
Ozone Resistance, 20% strain or bentloop, 300 pphm in air, 70 h @ 104°F	ASTM D 1149	no cracks
Oil Swell, ASTM Oil #3, 70 h @ 212°F, Wt. change, %, max.	ASTM D 471	45

(b) **Bond of Elastomer to Plastic:** Force required to shear elastomer from plastic shall be at least 5 pounds per linear inch of sealer when tested by DOTD TR 636.

(c) **Bond of Plastic to Cement Mortar:** Force required to separate cement mortar from plastic shall be at least 5 pounds per linear inch of sealer when tested by DOTD TR 636.

1007-5 PREFORMED POLYURETHANE JOINT FILLER: This material shall be a preformed polyurethane foam joint filler made with a semi-open, flexible polyurethane foam which is molded to such cross sectional shape that it can be easily installed in joint and which will be sufficiently self-locking to prevent material from floating out of joint. Molded polyurethane foam shall be free of defects and internal voids greater than ½" and shall show no deterioration when immersed in a 50% by volume solution of mineral spirits and linseed oil for 24 hours. When filler is used to form joint, self-locking feature will not be required and filler will extend full depth.

Properties of polyurethane foam when determined on skin-free specimens shall conform to the following requirements:

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<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Tensile Strength, psi, min.	ASTM D 412	1800
Elongation at Break, % min.	ASTM D 412	200
Hardness, Shore A	ASTM D 2240	65±10
Properties after Aging, 70 h @ 212°F		
Tensile Strength, % loss, max.	ASTM D 573	20
Elongation, % loss, max.		25
Hardness, pts. increase, max.		10
Ozone Resistance, 20% strain or bentloop, 300 pphm in air, 70 h @ 104°F	ASTM D 1149	no cracks
Oil Swell, ASTM Oil #3, 70 h @ 212°F, Wt. change, %, max.	ASTM D 471	45

¹ 65% deflection after 1-minute relaxation from deflection return.

Lubricant-adhesive recommended by joint filler manufacturer shall be applied according to manufacturer's directions.

1007-6 WATERSTOPS:

- (a) Copper waterstops shall conform to ASTM B 370, soft temper.
- (b) Polyvinyl chloride (PVC) waterstops shall conform to U.S. Army Corps of Engineers Specification CRD-C 572.
- (c) Rubber waterstops shall conform to U.S. Army Corps of Engineers Specification CRD-C 513.

SECTION 1008

**CONCRETE CURING MATERIALS,
ADMIXTURES AND FINISH COATING****1008-1 CURING MATERIALS:**

(a) **Liquid Membrane-Forming Compounds:** This material shall conform to AASHTO M 148 and be a product listed in the QPL. Types shall be Type 2 white-pigmented or Type 1-D, clear or translucent with a fugitive dye, as specified.

(b) Burlap Cloth shall conform to AASHTO M 182, Class 3.

(c) Waterproof Paper shall conform to AASHTO M 171.

(d) White Polyethylene Sheeting shall conform to AASHTO M 171.

(e) Combined Burlap and White Polyethylene Sheeting shall conform to AASHTO M 171.

1008-2 ADMIXTURES: Concrete admixtures shall be products listed in the QPL.

(a) **Water-Reducing Admixtures:** These admixtures shall conform to ASTM C 494, Type A.

(b) **Water-Reducing, Set-Retarding Admixtures:** These admixtures shall conform to ASTM C 494, Type D.

(c) **Set-Accelerating Admixtures:** These admixtures shall conform to ASTM C 494, Type C, and shall contain no chlorides.

1008-3 APPLIED FINISH COATING: This material shall be a product listed in the QPL and shall provide a uniform, fine-textured finish.

Material shall consist of a water-based coating containing pigments, texturizers, resins and water. Coating shall contain fungicides to prevent growth of mildew, mold, etc. No field additions to coating will be permitted.

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SECTION 1009

PRECAST CONCRETE BRIDGE MEMBERS

1009-1 MANUFACTURING PLANTS: Facilities for manufacturing precast concrete bridge members shall be DOTD approved, and equipment shall be in satisfactory working order.

1009-2 MATERIALS: Materials shall conform to the following Sections:

Portland Cement Concrete

(Class 6.5A5000) 1005

Reinforcing Steel 1006

1009-3 SHOP DRAWINGS: Shop drawings and details shall be submitted in accordance with Subsection 5-8. Such details shall include method and sequence of stressing, details of prestressing steel, holdups and holdowns, and other pertinent data. Friction losses shall be included in calculations submitted.

1009-4 NONPRESTRESSED MEMBERS: Lifting anchors shall be installed in accordance with shop drawings. In deck units, portions of anchors above deck surface shall be removed. Deck units shall be finished in accordance with Subsection 601-10.

Concrete and reinforcing steel shall be placed in accordance with Section 601. Members shall be held at plant for at least 10 days after casting.

1009-5 PRESTRESSED MEMBERS: Prestressing may be preformed by either pretensioning or posttensioning methods. Pretensioning of tendons shall be done in stages to allow for equalization throughout tendon.

(a) **Pretensioning Method:** Prestressing strands shall be accurately held in position and stressed by jacks. A record shall be kept of jacking force and tendon elongation produced. Several units may be cast in a continuous line and stressed at one time. Sufficient space shall be left between ends of members to permit access for cutting strands after concrete has attained required strength. No bond stress shall be transferred to concrete nor shall end anchors be released until concrete has attained specified release strength. Strands shall be cut or released in such order as to cause minimum eccentricity of prestress.

Strands to be prestressed in a group shall be brought to a uniform initial tension of 1,000 to 2,000 lb prior to full pretensioning. After initial tensioning, the group shall be stressed until required elongation and jacking pressure are attained.

With cables stressed in accordance with plan requirements and the foregoing specifications and with all other reinforcing in place, concrete shall be cast. Strands shall not be spliced within a member.

(b) **Posttensioning Method:** Tensioning process shall be so conducted that tension being applied to tendon and its elongation may be measured at all times. Friction loss shall be estimated as provided below. A record shall be kept of gage pressures and elongations. Loads shall not be applied to concrete until it has attained required 28-day compressive strength.

Posttensioning tendons of straight members may be tensioned from one end. Posttensioning tendons of curved members shall be stressed by simultaneous jacking from both ends of stressing element.

Friction losses in posttensioned steel shall be determined from the following formulas. Values of coefficients assumed for design and acceptable ranges of jacking stresses and steel elongation shall be as specified.

$$T_o = T_x e^{(KL + Ua)}$$

When $(KL + Ua)$ is not greater than 0.3, the following equation may be used:

$$T_o = T_x (1 + KL + Ua)$$

in which

T_o	=	Steel stress at jacking end.
T_x	=	Steel stress at any point x.
e	=	Base of Napierian logarithms.
K	=	Friction wobble coefficient per foot of prestressing steel.
L	=	Length of prestressing steel element from jacking end to point x, in feet.
U	=	Friction curvature coefficient.
a	=	Total angular change of prestressing steel element in radians from jack to point x.

The following values for K and U shall be used:

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Galvanized-rigid	0.0002	0.25
Bright metal bars	Galvanized-rigid	0.0002	0.15

(c) **Duct Enclosures:** Duct enclosures for prestressing steel shall be rigid, mortartight, and free of angle changes, crimping or flattening.

Ducts shall be rigid, galvanized, steel tubes with either welded or interlocked seams having sufficient strength to maintain correct alignment during placing of concrete. Galvanizing of welded seam will not be required. Joints between sections shall be positive metallic connections sealed with waterproof tape. Transition couplings connecting ducts to anchoring devices need not be galvanized.

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Duct openings or anchorage assemblies shall be provided with connections for injection of grout after prestressing. Ends of ducts shall be covered to prevent entry of water or debris. Ducts shall be free of water and debris prior to installation of prestressing steel. Inside diameter of ducts shall be at least 3/8" greater than outside diameter of tendon.

Duct shall be securely fastened in place to prevent movement during concrete placement. Vents shall be 1/2" diameter pipe connected at high points in duct with structural fasteners, and sealed with waterproof tape.

(d) **Anchorage:** Posttensioned prestressing steel shall be secured at ends by permanent anchoring devices. Anchors shall be of such design that they will not damage prestressing steel.

Anchorage devices for posttensioning shall hold prestressing steel at a load producing stress at least 95% of minimum tensile strength of prestressing steel.

Where end of posttensioned assembly will not be covered by concrete, anchoring devices shall be recessed so that ends of prestressing steel and all parts on anchor devices will be at least 2" inside end surface of members. Following posttensioning, recesses shall be filled with mortar and finished flush.

When headed wires are used, outside edge of any hole for prestressing wire through a stressing washer, or through an unthreaded bearing ring or plate, shall be at least 1/4" from root of thread of washer or from edge of ring or plate.

Distribution plates or assemblies shall conform to the following requirements:

(1) Final unit compressive stress on concrete directly underneath plate or assembly shall not exceed 3,000 psi, and a suitable grillage of reinforcing steel shall be used in stressed area.

(2) Bending stresses in plates or assemblies induced by pull of prestressing steel shall not exceed yield point of material or cause visible distortion in anchorage plate when 100% of ultimate load is applied.

Materials and workmanship shall conform to Section 602.

If anchoring devices are of a type which are sufficiently large and are used with an embedded steel grillage that effectively distributes compressive stresses to concrete, steel distribution plates or assemblies may be omitted.

(e) **Prestressing Steel:** Prestressing steel shall be high-tensile strength steel wire, high-tensile strength 7-wire strand or high-tensile-strength alloy bars.

Ends of pretensioned strands not to be encased in end diaphragms shall be cut off flush with ends of beam and coated with asphalt.

No more than 75% of minimum ultimate tensile strength of steel may be used with low-relaxation strands. For this design, final compressive stress in concrete shall be at least as great as that required for design using normal stress-relieved strands.

Steel of different ultimate strengths shall not be used interchangeably in same member.

Until finally encased in concrete or grouted in member, prestressing steel shall be protected against corrosion and damage, and shall be free of dirt, scale, oil, grease and other deleterious substances.

No welds or grounds for welding equipment shall be made on prestressing steel. If arc welding is utilized on other parts of a prestressed structure, ground shall be attached to part being welded.

(f) **Concrete Placement:** Concrete shall be placed in accordance with Subsection 601-8.

(g) **Grouting of Bonded Steel:** Posttensioned prestressing steel shall be bonded to concrete by pressure grouting the ducts. Grout shall consist of portland cement, water and a nonshrinking or expansive admixture.

Grout shall be mechanically mixed. Water content shall be not more than 5 gallons per 100 pounds of cement and shall first be added to mixer followed by cement and admixture. Grout shall be continuously agitated until pumped and shall not be retempered.

Pumpability of grout shall be determined by U.S. Corps of Engineers Test Method CRD-C 79. Efflux time of a grout sample immediately after mixing shall be at least 11 seconds.

Grouting equipment shall be capable of grouting at a pressure of at least 100 psi.

Standby flushing equipment capable of developing a pumping pressure of 250 psi and of sufficient capacity to flush out partially grouted ducts shall be provided.

Ducts shall be free of materials that impair bond of grout or interfere with grouting procedures. Immediately prior to grouting, duct shall be flushed with water containing 0.1 pound of hydrated lime or quicklime per gallon and then blown out with oil-free air.

Grout shall pass through a No. 10 U.S. Sieve prior to being pumped.

Grout injection pipes shall be fitted with positive mechanical shutoff valves. Vents and ejecting pipes shall be fitted with valves, caps or other devices capable of withstanding pumping pressures. Valves and caps shall not be removed or opened until grout has set. Leakage of

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grout through anchorage assemblies shall be prevented by devices capable of withstanding grouting pressures.

Grout shall be pumped through duct and continuously wasted at outlet until 15 seconds after all visible slugs of water or air are ejected. Outlet pipe shall then be closed and pumping pressure held momentarily. Inlet valve shall then be closed while maintaining this pressure.

After grouting, members shall not be disturbed for at least 24 hours.

Anchorage assemblies shall not be encased in concrete until duct grouting has been completed and concrete surfaces against which encasement is to be placed have been cleaned by abrasive blasting so as to expose aggregate.

(h) **Finish and Curing:** Prestressed members shall be finished in accordance with Subsection 601-10.6. Curing methods other than steam curing shall conform to Subsection 601-9.

Steam curing shall be done in a suitable enclosure. Initial application of steam shall be from 2 to 4 hours after final placement of concrete. When set retarders are used, waiting period before application of steam shall be from 4 to 6 hours. Steam shall be at 100% relative humidity. Application of steam shall not be directly on concrete. During application of steam, ambient air temperature shall be increased at a rate not to exceed 40°F per hour until a uniform temperature not exceeding 160°F is reached.

Steam curing shall continue at this temperature until concrete reaches release strength. At the contractor's option, temperature may be decreased to not less than 100°F after 6 hours and held at this temperature until time of detensioning. At this time, steam curing may be discontinued.

Concrete shall remain covered for at least 2 hours after steam curing has ceased, at which time detensioning shall be accomplished. The 2-hour cool-down period may be waived if fabricator demonstrates that there will be no adverse effect to members.

(i) **Transportation and Storage:** Precast girders shall be transported in an upright position. Points of support and directions of reactions with respect to girder shall be approximately the same during transportation and storage as when girder is in final position.

Members may be handled immediately after detensioning. If stressing is not done in a continuous operation, members shall not be handled before sufficiently stressed to sustain all forces and bending moments due to handling.

Prestressed members shall be held at plant for at least 14 days after casting.

SECTION 1010

MASONRY UNITS

1010-1 MANHOLE BRICK: Brick for manholes, inlets and junction boxes shall be clay or shale brick conforming to ASTM C 62, Grade SW, or concrete brick conforming to ASTM C 139.

1010-2 BUILDING BRICK:

- (a) Clay or shale brick for buildings shall conform to ASTM C 62, Grade MW.
- (b) Concrete brick for buildings shall conform to ASTM C 55, Grade N-II.

1010-3 FACING BRICK: Facing brick shall conform to ASTM C 216, Grade MW, Type FBS.

1010-4 CONCRETE BLOCKS: Hollow concrete load-bearing building blocks shall conform to ASTM C 90, Grade N-II.

1011-1**SECTION 1011****STRUCTURAL METALS**

1011-1 STRUCTURAL STEEL: Structural steel shall conform to ASTM A 709 for the following grades:

Type of Steel	Grade
Structural Carbon Steel	36
High-Strength, Low-Alloy Structural Steel	50
High-Strength, Low-Alloy, Corrosion Resistant Structural Steel	50 W
Quenched-Tempered, Low-Alloy Structural Steel	70 W
High-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding	100

1011-2 RIVET STEEL:

- (a) Structural Rivet Steel shall conform to ASTM A 502, Grade 1.
- (b) High Strength Rivet Steel shall conform to ASTM A 502, Grade 2.

1011-3 COPPER BEARING STEEL: Copper-bearing steel shall contain at least 0.2% copper.

1011-4 STEEL CASTINGS:

- (a) Steel castings shall conform to ASTM A 27, Grade 70-36.
- (b) High strength steel castings shall conform to ASTM A 148.
- (c) Chromium alloy steel castings shall conform to ASTM A 743, Grade CA-15.

1011-5 IRON CASTINGS: Iron castings shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their value for service intended. Castings shall be boldly filleted at angles, and rises shall be sharp and perfect. Castings shall be cleaned of scale and sanded to a smooth, clean, uniform surface.

- (a) Gray Iron Castings shall conform to ASTM A 48, Class 30.
- (b) Malleable Iron Castings shall conform to ASTM A 47, Grade 35018.
- (c) Ductile Iron Castings shall conform to ASTM A 536, Grade 60-40-18.

1011-6 STEEL BEARING PILES: Steel bearing piles shall conform to ASTM A 709, Grade 36.

1011-7 SHEET PILES: Steel sheet piles shall conform to ASTM A 328. Aluminum sheet piles shall conform to ASTM B 221, Alloy 6061-T6 or 6063-T6 or ASTM B 209, Alloy 3064-H34.

1011-8 STEEL PIPE PILES: Steel pipe piles shall conform to ASTM A 252, Grade 2.

1011-9 SHEAR CONNECTORS: Shear connector studs shall be Type B studs conforming to ANSI/AASHTO/AWS D 1.5-88.

1011-10 CONCRETE ANCHOR STUDS: Concrete anchor studs for end dam plates, bearing plates or other concrete anchorage shall be Type A studs conforming to ANSI/AASHTO/AWS D 1.5-88.

1011-11 BOLTS, NUTS AND WASHERS:

(a) **Carbon Steel Bolts, Nuts and Washers (Except High Strength Bolts):** Bolts shall conform to ASTM A 307, Grade A or B. Nuts shall conform to ASTM A 563. Circular washers shall conform to ASTM F 436.

(b) **High Strength Bolts, Nuts and Washers:** Bolts, nuts and washers shall have plain surface finish.

(1) Bolts shall conform to ASTM A 325 or A 490, as specified. For ASTM A 325 bolts, Type 1 bolts shall be used.

(2) Nuts shall conform to ASTM A 563, Grade DH or ASTM A 194, Grade 2H.

(3) Circular washers shall conform to ASTM F 436.

(c) **Galvanization:** Galvanization shall conform to ASTM A 153.

1011-12 RAILING PIPE: Pipe for railings and other structural uses shall be galvanized steel pipe conforming to ASTM A 53.

1012-1

SECTION 1012

PAINT

1012-1 GENERAL:

(a) **Packaging:** Paints shall be delivered in shipping containers conforming to Interstate Commerce Commission (ICC) requirements.

(b) **Identification:** Each container shall bear a label with name and address of manufacturer, trade name or trademark, kind of paint, color of paint, number of gallons, batch number and date of production.

(c) **Storage:** After 1 year from date of manufacture, material shall not show skinning, settling, color change, thickening or livering that cannot be eliminated by normal mixing procedures. No material shall be used after manufacturer's recommended shelf life.

1012-2 3- COAT ORGANIC ZINC AND TOPCOAT SYSTEM: This paint system shall consist of 2 coats of organic zinc primer and 1 vinyl topcoat and shall be a system on the QPL.

Thinning of primer shall be in accordance with manufacturer's recommendations, but not exceeding 12% by volume.

Primer shall be tinted for color contrast as follows:

1st Coat	Red
2nd Coat	Green

Thinning of topcoat shall be in accordance with manufacturer's recommendations, but not exceeding 10% by volume. Thinners shall be from same manufacturer as paint.

1012-3 COAL TAR EPOXY-POLYAMIDE PAINT: This paint shall conform to SSPC Paint No. 16.

1012-4 METALWORK PAINT: This paint is for coating iron castings for drainage and sewer structures, such as frames and covers for manholes and inlets. Paint shall be formulated from climate resistant resin and pure petroleum solvents and shall conform to the following requirements:

<u>Property</u>	<u>Test Method</u>	<u>Min.</u>	<u>Max.</u>
Color	By reflected light	Jet Black	
Wt, lb/gal	ASTM D 1475	6.9	---
Viscosity, KU @ 77°F	ASTM D 562	94	105
Solids, % by Weight	ASTM D 2369	50	---
Dry touch, minutes	ASTM D 1640	---	30
Dry through, hours	ASTM D 1640	---	3

SECTION 1013**TIMBER AND PRESERVATIVES**

1013-1 STRUCTURAL TIMBER AND LUMBER: Species and grade of structural timber and lumber shall conform to AASHTO M 168 and the following requirements.

(a) **Southern Pine:** Referring to Standard Grading Rules for Southern Pine Lumber published by the Southern Pine Inspection Bureau (SPIB), pine lumber shall be furnished in grades with unit working stresses assigned as indicated for grade of lumber required.

(1) Caps, stringers, decking and rails shall be Grade No. 1 Dense SR Timbers.

(2) Items other than caps, stringers, decking and rails shall be Grade No. 1 SR Timbers.

(b) **Douglas Fir:** Referring to Standard Grading Rules for Western Lumber, fir lumber shall be furnished in accordance with the following:

(1) Caps, stringers, decking and rails shall conform to Section 70.10, Select Structural. Design values shall be in accordance with Table 4, Recommended Design Values in Pounds Per Square Inch.

(2) Items other than caps, stringers, decking and rails shall conform to Section 70.11, Grade 1. Design values shall be in accordance with Table 4, Recommended Design Values in Pounds Per Square Inch.

1013-2 TIMBER PILES, POLES, POSTS AND BRACES:

(a) **Timber Piles:** Timber piles shall be Southern Yellow Pine or Douglas Fir conforming to ASTM D 25, except that Table 10-12 herein shall be used in lieu of Tables 1 and 2 in ASTM D 25.

(b) **Timber Poles:** Timber poles shall be Southern Pine or Douglas Fir conforming to ANSI D 1.5.

(c) **Timber Posts and Braces:** Posts and braces shall be cut from sound trees and shall contain no unsound knots. Posts and braces shall be free from decayed wood, rot and red heart. Ring shakes and season checks which penetrate more than 1/4" will be cause for rejection. Posts and braces shall show at least 4 annular rings per inch and at least 1/3 summer wood.

Fence posts shall be peeled for their full length and bark and inner skin removed. Knots shall be trimmed close to body of post before treatment. A line drawn from center of top to center of butt shall not be more than 2" from geometric center of post. Posts and braces shall be free from excessive bow, twist or other such defects. Ends shall be sawed square.

1013-3

Guard rail posts and spacer blocks shall be treated timber of Southern Pine Grade No. 1 or Douglas Fir Dense Construction quality. Posts and spacer blocks shall be fabricated before treatment.

TABLE 10-12
CIRCUMFERENCES AND DIAMETERS OF TIMBER PILE¹

	3 Feet from Butt (inches)				At Tip, Min. (inches)	
	Min.		Max.			
Length, feet	Circumference	Diameter	Circumference	Diameter	Circumference	Diameter
Under 40	38	12	63	20	25	8
40 to 54	38	12	63	20	22	7
55 to 74	41	13	63	20	22	7
75 to 90	41	13	63	20	19	6
Over 90	41	13	63	20	16	5

¹ Measurements shall be taken with the bark removed.

1013-3 TIMBER PRESERVATIVES: The following preservatives shall be used in accordance with Table 10-13 herein:

- (a) **Creosote:** Creosote shall conform to AWP A P1/P13.
- (b) **Creosote Solutions:** Creosote solutions shall conform to AWP A P2.
- (c) **Pentachlorophenol-Petroleum Solution:** Pentachloro-phenol-Petroleum Solution shall conform to AWP A P8 and P9.
- (d) **Chromated Copper Arsenate (CCA):** Chromated copper arsenate shall conform to AWP A P5, Type B or C. Material shall be kiln dried before treatment.

1013-4 TREATMENT:

- (a) **General:** Materials shall be treated according to current AWP A Standard Specifications for Preservative Treatment by Pressure Processes, modified as follows:

Timber and Lumber	C1 and C2
Piles.....	C1 and C3
Poles.....	C1 and C4
Round Posts	C1 and C5
Square Posts.....	C1 and C2
Fire Retardant Lumber.....	C1 and C20

Kiln-dried timber shall be steamed prior to treatment for at least 2 hours.

(b) **Amount of Preservative:** The amount of preservative shall be minimum specified in Table 10-13 herein determined by assay. Assay zone shall be as specified in AWPAs Standards, except bridge timbers which will require an assay zone of 0" to 1 1/2" from surface of material. AWPAs penetration requirements shall be met.

TABLE 10-13 MINIMUM PRESERVATIVE RETENTION¹ (Lb/cf of Wood)				
Material & Usage	Creosote	Creosote Solutions	Pentachlorophenol	CCA
Timber & Lumber (General Use)	12	---	0.6	0.6
Bridge Timber & Lumber	16	16	---	---
Piles (Except Foundation Piles):				
Pine	---	16	---	---
Fir	---	17	---	---
Foundation Piles:				
Pine	---	12	---	---
Fir	---	17	---	---
Poles: Pine	12	---	0.6	---
Fir	15	---	0.8	---
Fence Posts & Braces	8	8	0.4	0.4
Guardrail Posts & Spacer Blocks	12 ²	---	0.6	0.6
Railings & Dead End Installations	12 ²	---	0.6	0.6

¹ Preservatives for treated material to be painted shall be CCA or Pentachlorophenol.

² Steam flush for at least 1 hour at 240°F after treatment.

1014-1

SECTION 1014

FENCES AND GUARDRAIL

1014-1 CHAIN LINK FENCING: Materials shall conform to AASHTO M 181 except for the following.

(a) Wire ties, fabric ties, hog rings and tension wire for Type I, II or III fencing shall be either aluminum alloy, galvanized ductile steel or aluminum-coated ductile steel wire.

(1) **Wire Ties:** Wire ties, fabric ties and hog rings shall have at least 20,000 psi tensile strength and 10% elongation. Steel shall be coated with at least 0.6 ounce of zinc or 0.4 ounce of aluminum alloy per square foot. Wire ties shall be AWG No. 9. Fabric ties and hog rings shall be AWG No. 12.

(2) **Tension Wire:**

a. Galvanized and aluminum-coated steel tension wire shall be AWG No. 9 having at least 75,000 psi tensile strength with at least 0.7 ounce of zinc or 0.4 ounce of aluminum alloy per square foot.

b. Aluminum alloy tension wire shall be AWG No. 6 wire having at least 42,000 psi tensile strength, 35,000 psi yield strength, and 10% elongation.

(b) Barbed wire used with chain link fence shall conform to Subsection 1014-2.

(c) Padlocks shall be solid jacket, extruded brass with interchangeable cores and 1 3/4" cases. All padlocks shall be keyed alike and 2 keys furnished for each padlock.

1014-2 BARBED WIRE: Barbed wire shall be 12 1/2 gage steel or aluminum alloy.

(a) **Steel Barbed Wire:** Steel barbed wire shall conform to ASTM A 121.

(b) **Aluminum Alloy Barbed Wire:** Aluminum alloy barbed wire shall conform to ASTM B 211, Alloy 5052-0 for line wire and 5052-H38 for barbs.

1014-3 WOVEN WIRE: Woven wire shall conform to one of the following Design Numbers and Grades of ASTM A 116.

<u>Design No.</u>	<u>Grade</u>
939-6-11	60
939-6-12 1/2	60
939-6-14 1/2	60
939-6-12 1/2	125

1014-4 POSTS AND BRACES FOR FIELD FENCE: Posts and braces shall be steel or treated timber.

(a) **Treated Timber Posts and Braces:** Braces shall be round or square. Posts shall be round. Posts and braces shall conform to Section 1013.

(b) **Steel Posts and Braces:** Steel posts and braces shall have corrugations, knobs, notches, holes or studs so placed and constructed as to engage a substantial number of fence wires in proper position. Posts may be punched with holes in such position and of such size as will not unduly impair strength of posts. Posts with punched tabs are not acceptable.

Line posts, anchor plates and braces shall conform to ASTM A 702.

Steel posts, anchor plates and braces shall be galvanized in accordance with ASTM A 123.

1014-5 STAPLES AND NAILS: Staples and nails shall be made of galvanized steel wire. Galvanized coating shall be at least 0.2 ounce per square foot when tested by ASTM A 90.

1014-6 FASTENERS FOR STEEL POSTS: Fasteners shall be galvanized steel wire fasteners or clamps. Wire shall be at least 0.12" diameter. Galvanized coating shall be at least 0.2 per square foot when tested by ASTM A 90.

1014-7 GATES FOR FIELD FENCE:

(a) **Gates:** Steel sheets used in fabricating gates shall be galvanized in accordance with ASTM A 525, G 90 Coating Designation.

(b) **Posts:**

(1) **Treated Timber:** Treated timber posts shall conform to Section 1013.

(2) **Metal:** Metal posts shall be galvanized steel pipe conforming to ASTM A 53.

(c) **Hardware:** Hinges, washers, nails, staples, chains and latches shall be galvanized steel of acceptable quality and type.

(d) **Gate Stops:**

(1) **Treated Timber:** Gate stops shall be timber conforming to Subsection 1014-4(a) treated in the same manner as posts.

(2) **Metal:** Gate stops shall be galvanized steel suitable for welding.

(e) **Stop Posts:** Stop posts for gates shall be treated timber conforming to Section 1013.

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1014-8 WOOD FENCING:

(a) **Posts:**

(1) **Steel:** Posts shall be galvanized steel conforming to AASHTO M 181 or ASTM A 53.

(2) **Timber:** Posts shall be treated timber conforming to Section 1013.

(b) **Stringers:** Stringer rails shall be No. 2 pine or utility grade fir and shall be treated with chromated copper arsenate in accordance with Section 1013.

(c) **Pickets:** Pickets shall be No. 1 cedar.

(d) **Fasteners:** Fasteners shall be galvanized steel.

1014-9 METAL BEAM GUARDRAIL: Rail elements shall be corrugated steel beams. Rail elements, terminal sections and fittings shall be interchangeable with similar parts, regardless of manufacturer.

Rail, terminal sections and fittings shall conform to AASHTO M 180, Type II, Class B.

1014-10 GUARDRAIL POSTS AND SPACER BLOCKS: Railing posts shall be timber or steel. Spacer blocks shall be of same materials as post.

(a) **Timber Posts and Spacer Blocks:** Timber and treatment shall conform to Section 1013.

(b) **Steel Posts and Spacer Blocks:** Steel posts and spacer blocks shall conform to ASTM A 709, Grade 36 or A 769 (Grade 40) galvanized in accordance with ASTM A 123. Welding, if required, shall be in accordance with Subsection 602-15.

1014-11 GUARDRAIL HARDWARE: Splices, end connections, anchor rods and accessories shall be of such strength as to develop full design strength of rail elements.

Bolts shall conform to ASTM A 307 and nuts shall conform to ASTM A 563, Grade A.

Fittings, bolts, washers and other accessories shall be galvanized after fabrication in accordance with ASTM A 123, A 153 or B 695.

1014-12 WIRE ROPE AND FITTINGS FOR GUARDRAIL: Wire rope or wire cable and fittings shall conform to AASHTO M 30.

SECTION 1015**DRAIN PIPE**

1015-1 REINFORCED CONCRETE PIPE: Pipe shall conform to ASTM C 76, Class III. Gasket material shall be rubber gaskets conforming to AASHTO M 198, Type A.

1015-2 REINFORCED CONCRETE PIPE ARCH: Pipe arch shall conform to ASTM C 506, Class A-III. Gasket material shall be flexible plastic conforming to AASHTO M 198, Type B.

1015-3 CORRUGATED STEEL PIPE AND PIPE ARCH: Pipe shall conform to AASHTO M 36, Types I and II, amended as follows:

- (a) Pipe shall be galvanized in accordance with AASHTO M 218.
- (b) Helical pipe requiring joints shall have ends rerolled for at least 2 annular corrugations.
- (c) Pipe larger than 30" shall have lifting lugs.
- (d) Bituminous coated pipe shall be coated in accordance with AASHTO M 190, Type A.
- (e) Polymer coated pipe shall conform to AASHTO M 245, Grade 10/10.
- (f) Minimum gage shall be as shown in Tables 10-14 and 10-15 herein.
- (g) Coupling bands shall be same gage and coating as pipe (with a maximum of 12 gage) and gasket material shall be flexible plastic conforming to AASHTO M 198, Type B.

TABLE 10-14		
CORRUGATED STEEL PIPE		
GAGE REQUIREMENTS		
Pipe Diameter, Inches	Minimum Gage	
	2 2/3" x 1/2" Corrugation	3" x 1" and 5" x 1" Corrugation
12	16	---
15	16	---
18	16	---
21	16	---
24	14	---
30	12	---
36	12	14
42	12	14
48	12	14
54	12	12
60	12	12
66	10	12
72	10	12
78	8	12
84	8	10
90	---	10
96 & Larger	---	10

TABLE 10-15	
CORRUGATED STEEL PIPE ARCH	
GAGE REQUIREMENTS	
2 2/3" X 1/2" CORRUGATION	
Pipe Arch Size, Inches	Minimum Gage
17 x 13	16
21 x 15	16
24 x 18	14
28 x 20	14
35 x 24	14
42 x 29	14
49 x 33	12
57 x 38	12
64 x 43	10
71 x 47	8
3" x 1" AND 5" x 1" CORRUGATION	
95 X 67 & Smaller	14
103 x 71	12
112 x 75	12
117 x 79	12
128 x 83	10
137 x 87	10
142 x 91	8

1015-4 PLASTIC PIPE: Pipe may be of any of the following types and shall be products listed in the QPL. Joints shall be bell and spigot type with rubber gaskets conforming to ASTM F 477. Perforations, if specified, shall conform to AASHTO M 252.

1015-4.1 POLYVINYL CHLORIDE (PVC) PIPE:

(a) **Smooth Wall PVC Pipe:** Pipe 15" diameter or smaller shall conform to ASTM D 3034; pipe larger than 15" diameter shall conform to ASTM F 679, T-1 Wall.

(b) **Ribbed PVC Pipe:** Pipe shall conform to ASTM F 794, Series 46, and shall have a minimum cell classification of 12454-C as defined in ASTM D 1784.

(c) **Profile Wall PVC Pipe:** Pipe shall conform to ASTM F 949 and shall have a minimum cell classification of 12454-C as defined in ASTM D 1784.

1015-4.2 POLYETHYLENE (PE) PIPE:

(a) **Corrugated PE Pipe:** Pipe shall conform to AASHTO M 294, Type S, and shall have a minimum cell classification of 315412C as defined in ASTM D 3350.

(b) **Profile Wall PE Pipe:** Pipe shall conform to ASTM F 894, RSC 160, and shall have a minimum cell classification of 334433C as defined in ASTM D 3350.

SECTION 1016

SEWER PIPE

1016-1 GRAVITY SEWER PIPE:

1016-1.1 Plastic Pipe: Pipe shall have bell and spigot type push-on joints with rubber gaskets conforming to ASTM F 477.

1016-1.1.1 Polyvinyl Chloride (PVC) Pipe:

(a) **Smooth Wall PVC Pipe:** Pipe 15" diameter or smaller shall conform to ASTM D 3034; pipe larger than 15" diameter shall conform to ASTM F 679, T-1 Wall.

(b) **Ribbed PVC Pipe:** Pipe shall conform to ASTM F 794, Series 46, and shall have a minimum cell classification of 12454-C as defined in ASTM D 1784.

(c) **Profile PVC Pipe:** Pipe shall conform to ASTM F 949 and shall have a minimum cell classification of 12454-C as defined in ASTM D 1784.

1016-1.1.2 Polyethylene (PE) Pipe:

(a) **Corrugated PE Pipe:** Pipe shall conform to AASHTO M 294, Type S, and shall have a minimum cell classification of 315412C as defined in ASTM D 3350.

(c) **Profile Wall PE Pipe:** Pipe shall conform to ASTM F 894, RSC160, and shall have a minimum cell classification of 334433C as defined in ASTM D 3350.

1016-1.2 Ductile Iron Pipe: Pipe shall conform to AWWA C 151 and fittings shall conform to AWWA C 110. Pipe and fittings shall be cement mortar lined in accordance with AWWA C 104 and bituminous coated in accordance with ANSI A 21.51, and shall have push-on type rubber gasket joints conforming to AWWA C 111.

1016-2 FORCE MAIN SEWER PIPE:

1016-2.1 Ductile Iron Pipe: Pipe shall conform to AWWA C 151, Class 51, and fittings shall conform to AWWA C 110. Pipe and fittings shall be ceramic epoxy lined and bituminous coated.

Coating shall conform to ANSI A 21.51.

Lining material shall be a 2-component epoxy conforming to the following:

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Permeability, min.	ASTM E 96	13 perms
Impact Resistance, min.	ASTM D 2794	10 in-lb
Quartz Pigment, min.	--	20% by vol.

Lining material shall be applied in accordance with manufacturer's recommendations to a minimum dry film thickness of 24 mils in 1 coat.

Completed lining shall be tested for holidays with a 67-volt wet sponge detector, and all holidays shall be repaired.

1016-2.2 Steel Pipe: Pipe less than 6" diameter shall be galvanized steel pipe conforming to ASTM A 53, Type E or S, Grade A.

Pipe 6" diameter and larger shall conform to AWWA C 200, Class 125. Fittings shall conform to AWWA C 208. Pipe and fittings shall be coal-tar lined and coated in accordance with AWWA C 203.

1016-2.3 Polyvinyl Chloride (PVC) Plastic Pipe:

(a) **Pipe:** Pipe shall conform to the following:

Pipe Diameter	Requirement
Under 4"	ASTM D 2241, SDR 21, Min. Cell Class 12454-B (ASTM D 1784)
4" thru 12"	AWWA C 900, SDR 18, Class 150
Over 12"	AWWA C 905, SDR 25, Class 165

(b) **Unrestrained Joints:**

(1) Pipe under 4" diameter shall have solvent cement joints. Solvent cement shall conform to ASTM D 2564 and primer shall conform to ASTM F 656.

(2) Pipe 4" diameter or larger shall have rubber gasket bell and spigot or coupling type joints conforming to ASTM D 3139.

(c) **Restrained Joints:**

(1) Pipe under 4" diameter shall have solvent cement joints conforming to ASTM D 2672.

(2) Pipe 4" diameter or larger shall have flanged ductile iron fittings conforming to AWWA C 110.

SECTION 1017

PRECAST CONCRETE SEWER AND DRAIN UNITS

1017-1 PRECAST CONCRETE BOX CULVERTS: Precast reinforced concrete box culvert sections shall conform to ASTM C 850, table 1.

1017-2 PRECAST CONCRETE MANHOLES: Precast reinforced concrete manhole sections shall conform to ASTM C 478. Frames and covers shall conform to Subsection 1011-5. Lifting inserts shall be embedded in manhole walls; through-wall holes will not be permitted.

Pipe connection openings shall be 4"±1/2" larger than pipe O.D.

Sewer manhole bases shall have paved inverts, and sewer manhole sections shall have rubber gaskets joints conforming to ASTM C 443.

1017-3 PRECAST CONCRETE DRAIN INLETS AND JUNCTION BOXES: Materials, workmanship and curing shall be as specified for precast manholes in ASTM C 478. Frames, grates and covers shall conform to Subsection 1011-5.

Lifting devices shall be embedded in walls; through-wall holes will not be permitted.

Pipe connection openings shall be 4"±1/2" larger than pipe O.D.

1017-4 SEWER MANHOLE PLASTIC LINER: Plastic liner sheet, joint, corner and weld strips shall be manufactured from polyvinyl chloride resin and other ingredients compounded to make a permanently flexible material. Polyvinyl chloride resin shall constitute at least 99% by weight of resin used in the formulation. Copolymer resins will not be permitted.

(1) **Properties:** Liner sheet, locking extensions, joint, corner and weld strips shall be free of defects affecting their protective performance. Liner sheet, joint, corner and weld strips (except at shop welds) shall meet the following requirements:

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
Tensile Strength, psi, min.	ASTM D 412	2,200
Elongation at Break, %, min.	ASTM D 412	200
Shore Durometer, Type D:	ASTM D 2240	
Within 1 sec.		50-60
Within 10 sec.		35-50

Liner locking extensions embedded in concrete shall withstand a test pull of 100 pounds per linear inch, applied at 75±5° F perpendicular to concrete surface for 1 minute, without rupture of locking extensions or withdrawal from embedment.

Shop-welded joints used to fuse sections of liner together shall be at least equal to minimum requirements for liner for thickness, corrosion resistance and impermeability. Welds shall show no cracks or separations. Tensile strength measured across welded joint in accordance with ASTM D 412 using Die B shall be at least 2,000 psi. Test temperature shall be $77 \pm 5^{\circ}$ F and measured minimum width and thickness of reduced section shall be used.

Liner shall be shop tested for holes with a spark tester at 15,000 to 20,000 volts. Sheets having holes shall be repaired prior to shipment.

(2) **Dimensions:** Liner sheets shall be at least 0.065" thick. Locking extensions (T-shaped) of same material as liner shall be integrally extruded with sheet. Locking extensions shall be approximately 2 1/2" apart and at least 0.375" high.

Liner sheets shall be sized to provide required coverage. Joint strips shall be at least 0.075" thick, $4 \pm 1/4$ " wide and have beveled edges. Weld strips shall be at least 0.094" thick and $1 \pm 1/8$ " wide. Welding and outside corner strips shall have beveled edges.

(3) **Strap Channels:** Liner sheets shall have strap channels at not more than 20" on center perpendicular to locking extensions. Channels, 1" wide maximum, shall be formed by removing locking extensions at strap locations so that a maximum of 3/16" of base remains in strap channel. Strap channels shall not be provided in final 2 locking extensions adjacent to terminal edge of liner coverage.

(4) **Adhesive:** Liner shall be bonded to concrete surface in accordance with manufacturer's instructions.

SECTION 1018

PACKAGE FLOODED SUCTION SEWAGE PUMP STATIONS

1018-1 GENERAL: Pump stations shall be factory-built, automatic, underground package units including pump chamber, entrance tube and necessary equipment. Equipment shall include non-clog sewage pumps, internal piping, valves, control panel, lighting, ventilation, heater, dehumidifier, sump pump, cathodic protection and all internal wiring.

1018-2 PUMP CHAMBER AND ENTRANCE TUBE: Station shall be built in 2 sections consisting of equipment chamber and entrance tube joined at jobsite by welding. Field joint shall be cleaned and coated with epoxy resin. Equipment chamber shall contain pumps and other equipment and shall be of vertical cylindrical configuration.

Equipment chamber shall be fabricated of ASTM A 709, Grade 36 steel plate and beams. Top and bottom of chamber shall be a minimum 3/8" thick steel plate reinforced by wide flanged steel beams continuously welded to plate so that all seams between them are sealed against water penetration.

Wall thickness of cylinder shall be determined by structural requirements for depth of bury, but shall be at least 1/4". Manufacturer shall determine structural requirements based on external loads. Structural calculations shall be provided, certified and stamped by a professional registered engineer.

Plate forming top and bottom of equipment chamber shall be assembled and welded to vertical wall to form a Tee joint which shall be continuously welded to form a watertight seal.

Lifting eyes shall be incorporated within top reinforcement beams of equipment chamber. Lifting eyes shall also be provided inside equipment chamber over each pump at an adequate height so a hoist can be used for service work.

A 9" deep sump fabricated of 1/4" steel plate shall be provided to accept specified sump pump.

Mechanical joint wall sleeves shall be provided where suction and discharge lines pass through station wall. Sleeve shall have 2 compression joints with rubber gaskets; 1 inside and 1 outside. Sleeve shall absorb normal vibration distortion and maintain a leakproof seal.

Entrance tube constructed of minimum 1/4" thick ASTM A 709, Grade 36 steel plate shall be provided in 1 or more sections.

Entrance tube shall have an OSHA approved aluminum ladder, with folding extension on upper section that automatically extends in line with ladder when entrance tube cover is raised. Entrance tube shall have domed fiberglass cover with angle iron frame attached to wide span hinge pin. Cover shall be provided with drip lip around edge and shall be fitted with weatherproof lock of pin and tumbler type with inside keyless release. Lock shall be self locking upon closing cover. When

cover is in full open position, a lock open device shall engage to prevent accidental closing of cover.

1018-3 WELDING: Welding shall be in accordance with standard AWS practices. Welds shall be free from embedded scale or slag, shall have tensile strength across weld not less than that of thinner of connected sections, and shall be watertight. Welds in contact with soil or water shall be tested with dye penetrant to assure watertightness.

1018-4 PAINTING: Mill scale, rust, weld flux and other foreign matter shall be removed from steel surfaces by blast cleaning in accordance with SSPC SP10. Surface irregularities shall be removed by grinding.

Exterior surfaces below grade shall be coated with a self priming, chemically cured, catalyzed epoxy or polyurethane applied in 1 coat to a minimum dry film thickness of 16 mils.

Interior and exterior above grade surfaces shall receive 1 coat of epoxy primer followed by 2 coats of hi-build epoxy coating. Prime coat shall be applied to a minimum dry film thickness of 1.5 mils. Finish coats shall be a minimum dry film thickness of 2 mils each coat.

Paint touch-up kits shall be provided for coating field welds and damaged areas.

Floor in working areas within station shall be protected with heavy dielectric neoprene matting cemented to floor.

1018-5 CATHODIC PROTECTION: Exterior surfaces of station shall be protected from corrosion by a factory installed impressed current cathodic protection system capable of providing corrosion control in soil environments up to 100,000 ohm centimeter resistivities.

Rectifier shall have a minimum of 300 volt/amp output and be housed in a dust-proof enclosure utilizing heat sinks for cooling by natural air convection. Unit shall be capable of operating in the following modes without tap settings:

1. Constant current with electronic voltage limiting.
2. Constant voltage with electronic current limiting.

Unit shall contain environmentally sealed components and utilize self diagnostic, plug-in control modules to facilitate troubleshooting and maintenance.

Rectifier shall be capable of operating with 100-130 or 200-260 VAC, 60 Hertz, single phase input with DC output filtered to less than 1% ripple. Current and voltage control shall have a linear adjustment 0-100% of rated output. Unit shall be provided with indicator lights to facilitate monitoring and shall include a down time circuit capable of storing actual time of acceptable operating level during life of system.

1018-6

Factory installed anodes shall be Dimensionally Stable Anodes (DSA-R) comprised of mixed metal oxides catalyst sintered to high purity grade titanium base materials. Anode element shall be 3" in diameter by 40" long.

A long-life monitoring electrode shall be copper/copper sulfate type designed for underground applications with a stability of ± 5 millivolts.

Anode lead wires and monitoring electrode wire shall enter station thru a compression type fitting. No anode lead wires shall be exposed to contact with soils.

Owner shall be provided with 2 Operation and Maintenance manuals, and a copy of all pertinent test data along with an on-site training seminar to insure system continuous performance.

1018-6 SEWAGE PUMPS: Pump openings and passages shall be large enough to permit passage of material which will pass through a 4" diameter house collection system.

Pumps shall be vertical, built-together, non-clog cast iron sewage pumps and shall include a vertical motor with impeller mounted directly to motor shaft.

Pump volute and suction elbow shall be cast iron and furnished with large cleanouts and inspection openings. Pump shall permit removal of rotating assembly without disturbing piping.

Impeller shall be cast iron of 1-piece, single suction, enclosed, non-clog design. Impeller shall be statically and dynamically balanced, keyed and locked to motor shaft. Pump shall be equipped with 300-350 brinell hardness stainless steel impeller and casing wear rings. Common pump and motor shaft shall be alloy steel with a minimum tensile strength of 90,000 psi, of sufficient size to carry the maximum loads imposed and shall have renewable 400 series stainless shaft sleeves in seal area. Pump shaft shall be sealed against leakage by a double mechanical seal installed in a 1-piece cast iron housing.

Seal shall be of double carbon and ceramic construction held in a mating position by a stainless steel spring.

Mechanical seal shall be pressurized and lubricated by water taken from pump volute and passed through a filter that will screen out solids larger than 50 microns.

Pump motors shall be vertical solid shaft, open drip proof ball bearing induction motors. Motors shall be NEMA design B with normal starting torque, class B insulation rated for continuous duty with low starting current and a 1.15 service factor. Motor shall have a minimum B-10 life of 40,000 hours. Bearing calculations shall be provided.

Pump's limits of vibration set forth in Hydraulic Institute standards shall govern.

Pumps shall be tested at manufacturer's plant before shipment. Test shall consist of checking unit at specified rated speed, capacity, efficiency, brake horsepower and at other conditions of head and capacity to provide a certified performance curve. Hydraulic Institute standards shall govern procedures and calculations for these tests.

1018-7 MOTOR CONTROL AND PROTECTION: Control equipment shall be mounted within a NEMA type 1 enclosure with hinged door, fabricated of steel and reinforced as required. Circuit breakers, motor starters, reset buttons and pump control switches shall be mounted so they are operable without opening door.

Control panel shall conform to the NEC and shall be UL listed and labeled in accordance with UL standard No. 508.

Pump motors shall have short circuit and overload protection by means of properly sized motor starters. Thermal magnetic molded case circuit breakers shall be provided as disconnect switches and to provide protection against short circuits or grounds of each pump motor. Circuit breakers shall have an interrupting rating of 14,000 amps at 460 volts and shall be UL listed. Operating mechanism shall allow manual switching and shall indicate when breaker has tripped.

A wall mounted convenience duplex outlet shall be provided for operation of 115 volt AC devices.

Magnetic across-the-line starters with manual reset shall be provided with melting alloy type overload relays for each phase. Starters shall be NEMA size 1.

An electrical distribution center consisting of thermal magnetic circuit breakers with a minimum capacity of 15 amps shall be provided for each branch circuit including the following:

- Control
- Sump Pump
- Dehumidifier
- Blower
- Heater
- Convenience Receptacles
- Lighting

Circuit breakers shall indicate when circuit is open and shall have means provided for manual switching. Breakers shall be labeled as to function with permanently attached phenolic nameplates.

Pumps shall alternate automatically on completion of each pumping cycle. One pump shall start as lead pump and the other pump shall be started if wet well level continues to rise to start level for lag pump. After each operating cycle, lead and lag positions will alternate. A manual selector switch shall also be provided so that the operator can designate either pump to stay in lead position continuously. Adjustable time relays shall be provided to prevent simultaneous starting of pumps after power failure.

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1018-8 STORED AIR SYSTEM: To control operation of pumps with variations of sewage level in wet well, an air bubbler system shall be provided, complete with 2 air compressors, air receiver, flow indicator, wet well level gage, bubbler line and sensitive pressure switches for each pump.

Compressors shall be close-coupled oil-less type. Each compressor shall be capable of supplying 0.9 cfm free air at 50 psig. A 3-gallon air receiver with drain cock shall be provided. Compressor shall be controlled by individual pressure switches and an automatic alternator to maintain 20 to 40 psig pressure to air receiver. Compressors shall be mounted on air tank and entire assembly mounted on station wall remote from operating devices to prevent vibration from being transmitted to these devices. Wiring and air lines shall be arranged so that removing one compressor from service does not interrupt air supply.

Air pressure shall be reduced by a pressure reducing valve. Air flow rate shall be indicated with a purge type rotometer with a needle valve to regulate rate. A wet level gage, 0" to 160" range, shall be provided. A purge system shall be provided to divert full tank pressure to system to blow out bubbler line. Air control system shall contain check valves to prevent back flow through compressors.

1018-9 WIRING: Wiring shall comply with the NEC and state and local codes. Wiring shall be factory installed except for power lines that run to control panel from external disconnect switch, and wires connecting to operating devices not mounted in station.

Wiring within equipment chamber and outside control panel shall be run in PVC rigid conduit except for liquidtight metallic flexible conduit to connect pump motors. Accessory items such as sump pump and dehumidifier with approved manufacturer's rubber cord may be plugged into polarized ground outlets.

1018-10 CHAMBER LIGHTING: Equipment chamber shall be lighted by 2 dual, 40-watt, rapid start fluorescent light fixtures with guards installed within chamber. An automatic and manual light switch shall be provided at top of entrance tube.

1018-11 PIPING AND VALVES: Pump suction lines shall be class 53 ductile iron pipe terminating in mechanical joint wall sleeve. Each suction line shall have an isolation valve inside chamber.

Discharge line from each pump shall have check valve and isolation valve. Common discharge shall be class 53 ductile iron pipe which shall pass through a mechanical joint wall sleeve terminating in a plain end.

Gate valves shall be resilient wedge type, non-rising stem design.

Valve body shall be cast iron and valve shall have bronze stems with O-ring seals above thrust collar. Gates shall be encapsulated in rubber where exposed to line velocity, be field replaceable and

provide a dual seat on mating body seat. Valve shall conform to AWWA specifications.

1018-12

Horizontal swing check valves shall be installed in discharge piping. Valve shall permit flow in one direction only and close tightly without slamming when discharge pressure exceeds inlet pressure. Valve body shall be provided with an outside lever and spring to accomplish quicker closing and minimize slamming when rapid flow reversal is encountered. Valve in full open position shall permit full flow through valve equal to nominal pipe diameter. Valve body shall be cast iron bronze fitted with stainless steel hinge pins and O-ring packing.

Air bubbler line to wet well shall be 3/4" galvanized steel pipe. An angle bracket shall be welded to outside of chamber over bubbler pipe connection to receive a 3" x 3" x 1/4" angle brace to protect bubbler pipe. Steel pipe in contact with soil or sewage shall be field coated with epoxy resin to a minimum dry film thickness of 8 mils. Air bubbler pipe in wet well shall be 3/8".

1018-12 SUMP PUMP: Station shall be provided with an automatic operated submersible sump pump with a vertical close coupled motor.

Pump shall be cast iron, and integral pump and motor shaft shall have sealed bearings and replaceable mechanical seal to exclude water from motor housing. Motor shall be thermally protected and of adequate horsepower to meet operating conditions of 100 gph at finished grade.

Sump pump shall discharge through 1-1/4" PVC pipe with 2 check valves and a gate valve terminating in a steel coupling welded in chamber wall. An enclosure of heavy mesh shall surround sump to keep out debris.

1018-13 DEHUMIDIFIER AND VENTILATOR: A dehumidifier assembly with hermetically sealed freon refrigeration type compressor, expansion coil, fan and condenser coil shall be furnished to maintain relative humidity to prevent condensation on walls. Dehumidifier shall be controlled automatically by an adjustable humidistat located on dehumidifier, and shall have automatic defrost control, with low temperature cut out.

Dehumidifier shall be housed in a steel enclosure fastened to station wall. Condensate shall be drained to sump.

Dehumidifier shall have a capacity of 24 pints per 24 hours at 80°F and 60% relative humidity.

Fresh air from outside shall be drawn into pump chamber through an air inlet line which may form one side rail of ladder, and discharge directly into inlet of dehumidifier so that most moisture may be removed before air is circulated within station. A blower housed in dehumidifier enclosure shall pick up air from within 18" of floor and discharge it to open air through a second vent line which may serve as one of the side rails of ladder. Blower shall be squirrel cage high efficiency type of adequate capacity to change air every 2 minutes. Blower and lights shall be turned on automatically when entrance cover is raised by activating a double pole, spring operated limit switch mounted under cover. A manual switch shall be mounted in side of duct below limit switch for operation of lights

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and blower with cover closed. Blower shall be controlled by a 10-minute cycle timer with a range of 0 to 100%.

Steel vent openings shall have covers to prevent entrance of rain or snow and screened openings to prevent entrance of rocks, rodents or other foreign matter.

1018-14 HEATER: Equipment chamber shall be provided with a wall mounted 1500-watt electric heater suitable for 120-volt, single phase service.

Heater shall be fan-forced type with integral automatic dial type thermostat, copper anodized aluminum reflector, safety grill, UL approved electric cord and 3-prong plug.

1018-15 FACTORY TESTS: Completed pump station shall be given a running test of equipment at factory to check for excessive vibrations, leaks in piping or seals and correct operation of automatic control system and auxiliary equipment. Pump suction and discharge lines shall be coupled to a reservoir and pumps shall recirculate water for at least 1 hour simulating actual service conditions. Automatic control shall be adjusted under such operating conditions to start and stop pumps at approximate levels required by job conditions.

1018-16 STATION START-UP: After installation is complete, the manufacturer shall provide the services of a factory trained representative for 1 day to perform initial start-up of pump station and instruct owner's personnel in operation and maintenance of equipment.

SECTION 1019**SUBMERSIBLE SEWAGE PUMP STATIONS**

1019-1 GENERAL: Pump stations shall be automatic underground stations consisting of concrete wet well and valve pit structures and necessary equipment. Equipment shall include an automatic duplex or triplex pumping system with pumps, level controls, piping, valves, control panel and wiring.

1019-2 WET WELL AND VALVE PIT: These structures shall consist of reinforced concrete base and top cover slabs, and precast wet well sections and valve pit.

Design of concrete structures shall be the contractor's responsibility and shall be coordinated with equipment to be supplied to ensure proper slab openings and spacing for equipment. Structures shall be designed to support overburden and AASHTO H-20 loading.

Shop drawings, certified and stamped by a registered professional engineer, shall be submitted in accordance with Subsection 5-7.

Cast-in-place concrete shall be Class 6A4000 conforming to Section 1005. Reinforcing steel shall conform to Section 1006. Precast well sections shall conform to ASTM C 478 or C 76, or AWWA C 301.

Joints between concrete sections, and wall penetrations, shall be sealed with a hydrophilic elastic sealant.

Concrete fillets shall be provided at bottom of well and shall be shown on shop drawings.

Hatch shall be rectangular prefabricated aluminum. Hatches with either dimension over 3'-6" shall be doubled leaf type. Hatch doors shall be 1/4" aluminum diamond pattern plate designed to withstand a live load of 300 psf. Channel frame shall be 1/4" aluminum with anchor flange around perimeter. Hatch shall have heavy forged brass hinges, stainless steel pins, spring operators and an automatic hold-open arm with release handle. A snap lock with removable handle shall be provided. Each hatch shall be furnished with a removable threaded aluminum plug to seal lock aperture. Hatch hinges shall be welded to hatch assembly. Opening dimension shall be with hatches opened at 90° upright. Hatch clear openings shall provide a minimum 2" clearance on all sides for removal of equipment. All parts shall be welded, including hinges and stiffening angles. Well shall have a 4" ductile iron vent pipe.

Exterior surfaces of wet well and valve pit shall be coated with coal tar epoxy to a minimum dry film thickness of 18 mils. Interior surfaces of wet well shall be lined with a polyvinyl chloride (PVC) liner conforming to Subsection 1016-1(b).

1019-3 PUMPS:

(a) **General:** Each pump shall be fitted with a 1/4" diameter stainless steel lifting cable of adequate length to be accessible from ground surface and lift pump from wet well.

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Brass or stainless steel nameplates giving name of manufacturer, rated capacity, head, speed, serial number, model number, horsepower, voltage, amperes and other pertinent data shall be attached to pump.

Pumps shall have power and sensor conductors encapsulated in a single cable. Cable shall be fixed to pump using a watertight compression assembly. Watertight connectors with neoprene glands shall be furnished and installed in control panel enclosure to terminate each conduit and seal each cable entry into panel. Pump power and sensor cables shall be continuous between pump and control panel with no splices. Motor power and sensor cable shall be P-122 MSHA type insulated cable with a double jacketed protection system, neoprene outside, synthetic rubber inside, meeting industry standards for oil, gas and sewage resistance.

Mated surfaces shall be machined and fitted with O-rings for watertight sealing.

Manufacturer shall test pumps prior to shipment in accordance with Hydraulics Institute Standards. Flow, head, current draw and input KW shall be recorded for at least 5 points including the following 3 points on flow/head curve:

1. shut-off
2. design flow
3. minimum TDH and flow

Certified copies of test report shall be furnished for each pump.

A complete set of manufacturer's recommended spare parts, including 1 set of bearings, shall be provided with each pump.

(b) **Grinder Pumps:** Pumps shall be centrifugal type with integral grinder unit and submersible motor. Grinder unit shall be capable of macerating all material in normal domestic sewage.

Grinder unit shall be threaded onto a common pump and motor stainless steel shaft and be located on suction side of pump impeller. Cutter assembly shall consist of at least 2 cutting faces, 1 stationary face and 1 rotating face. Grinder pumps employing 2-stage cutter assemblies will be acceptable, provided secondary cutter provides cutting action in a plane perpendicular to cutting action of primary cutter. Systems using 2-stage cutters shall employ reversible stationary and secondary cutters. Pump shall be designed so cutter assemblies can be reversed or replaced without disturbing pump seals or motor.

Pump impeller shall be semi-open, non-overloading design, cast iron or bronze, threaded onto a common motor and pump stainless steel shaft.

Motor shall be protected by tandem mechanical shaft seals with an oil filled cavity separating seals. Seals shall have carbon rotating face

and ceramic stationary face with faces running in oil. Pumps shall have an ambient temperature compensated overheat sensing device in motor, and a moisture sensing device in the oil-filled cavity separating the mechanical seal to detect seal failure.

Pump motor shall be submersible type rated at a maximum of 3,500 rpm. Pump motors shall be 3-phase, 200V or 230/460V as specified. A single pump motor power cable shall be furnished for each pump. Control conductors shall be included in cable for winding temperature and seal failure sensors.

(c) **Non-Clog Pumps:** Pumps shall be non-clog centrifugal pumps with submersible close coupled motors designed to pump unscreened sewage. Design shall be such that pumping units shall be automatically connected to discharge piping when lowered into place on discharge connection. Pumps shall be easily removed from discharge connections and wet well for inspection or service. Lifting pumps from discharge connections or wet well shall require neither removal of bolts, nuts or other fastenings nor personnel to enter well.

Impeller shall be ASTM A 48 Class 30 gray cast iron. Design shall permit low liquid velocities, gradual acceleration and change of flow direction. Impeller/ casing design shall result in a passage free of surfaces to which solid or fibrous materials can adhere. Pump design shall combine high efficiency, low required NPSH, large sphere passage and ability to handle high solids concentrations efficiently. A wear ring system shall be provided between volute and impeller, and shall be easily replaceable. Pumps larger than 10 hp shall be fitted with dual wear rings; a stationary ring attached to volute and a rotating ring attached to impeller. All other parts shall be gray iron, with parts in contact with sewage protected with coatings specified. External bolts and nuts shall be stainless steel. Impeller shall be centrifugal non-clog type, capable of passing fibrous material and 3" diameter solids. Impeller shall be trimmed or tabbed to meet conditions stated in pump station data table at design point, within Hydraulics Institute tolerances. Impeller should closely meet conditions at auxiliary design point, but Hydraulics Institute tolerances are not required at this point. Pump efficiency shall be maximized at or near auxiliary design point.

Pump shall be provided with a tandem double mechanical seal running in an oil reservoir, composed of 2 lapped face seals. Top seal shall consist of a tungsten carbide stationary face and a carbon rotating face; bottom seal shall consist of 1 stationary and 1 rotating tungsten carbide face. Each pair of seals shall be held in contact by a separate spring so that outside pressure assists spring compression in preventing seal faces from opening. Compression spring shall be protected against exposure to pumped liquid. Pumped liquid shall be sealed from oil reservoir by bottom face seal, and oil reservoir from motor chamber by top. Seals shall require neither maintenance nor adjustment and shall be easily replaced.

Pump shaft shall rotate on permanently lubricated ball bearings sized to withstand axial and radial forces. Bearing life shall be at least 30,000 hours.

1019-4

A sliding guide bracket shall be an integral part of pumping unit and pump casing shall have a machined connection flange to connect with cast iron discharge connection, which shall be bolted to floor of sump with stainless steel anchor bolts and designed to receive pump connection without bolts or nuts. Sealing of pumping units to discharge connection shall be accomplished by a downward motion of pump with pumping unit guided by 2 stainless steel guides. No portion of pump shall bear on floor of sump. Pumping unit shall be sealed tightly against discharge connection. Pump with its appurtenances shall be capable of continuously submerging underwater without loss of watertight integrity to a depth of 65 feet.

Pump motors shall be housed in an air filled or oil filled watertight casing, and shall have Class F insulated windings which shall be moisture resistant. Motors shall be NEMA design B with a 1.15 service factor rated 155°C, Code Letter G or H, or better. Motors shall have cooling characteristics suitable to permit continuous operation in a totally, partially or non-submerged condition. Motor shall incorporate 3 ambient temperature compensated overheat sensing devices, 1 in each motor winding, and shall incorporate a moisture sensing device wired in series. Protective devices shall be wired into pump controls in such a way that if either device operates, pump will shut down. Temperature device shall be self-resetting. Motors up to 30 HP shall be either 200 volts for 208-volt service or 230/460 volts for 240/480-volt service as specified. Motors above 30 HP shall be 460 volts. Pump motor shall be capable of running pump continuously in a totally dry condition under full load without damage for extended periods, and shall be non-overloading within range of operation.

Pump and its driving equipment shall withstand maximum turbine run-away speed of unit due to backflow through pump.

1019-4 ACCESS FRAMES, GUIDES AND CABLE HOLDERS: Pump station shall have aluminum access frames with hinged and hasp-equipped covers, stainless steel upper guide holder and level sensor cable holder.

Frames shall be securely mounted above pumps. Hatches shall be as described in Subsection 1019-2. Surfaces of frames to be in contact with concrete shall be coated with zinc chromate primer.

Lower guide holders shall be integral with discharge connection. Guide bars shall be Schedule 40 stainless steel pipe.

Intermediate guide brackets shall be installed so that maximum length of unsupported guide bars will be 15 feet, and shall be stainless steel.

Cable holders and cable hooks shall be stainless steel. Sharp corners and edges shall be ground smooth. Cable holder shall be of sufficient length and strength to provide support for each cable, except that pump power and lift cables may use same hook position, provided cables do not foul one another and lift cable is easily accessed from hatch opening.

1019-5 CONTROL EQUIPMENT:

1019-5.1 General: Electronic equipment shall be manufacturer's latest design, utilizing printed circuitry and coated to prevent contamination by dust or moisture.

Instrumentation shall produce or be activated by signals which are established standards for wastewater. Instrumentation shall utilize linear transmission signals of 4-20 mADC; however, signals between instruments within same panel or cabinet may be 1-5 VDC. Outputs of equipment that are not standard signals shall have output converted to compatible standard signals for transmission. Zero based signals will not be allowed.

Indicators and recorder readouts shall be linear in process units. Transmitters shall be provided with either integral indicators or conduit-mounted indicators in process units, accurate to 2%.

Equipment, cabinets and devices shall be designed for continuous industrial service. The system shall contain products of a single manufacturer to the extent possible. Equipment shall be of modular construction capable of field expansion. Instruments shall be provided with mounting hardware and floor stands, wall brackets or instrument racks as required. Field mounted equipment shall have NEMA 4 or 4x housing.

Equipment shall be designed to operate on a 60 Hz 117 VAC \pm 10%. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, power conditioners shall be supplied.

Analog transmitter and controller outputs shall be 4-20 mADC into a load of 0-750 ohms.

Switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA.

Equipment shall automatically reset after power outages or spurious signals.

1019-5.2 Field Mounted Equipment: Field mounted equipment shall be provided in accordance with Table 10-16 herein.

TABLE 10-16

FIELD MOUNTED EQUIPMENT

Equipment (Manufacturer)	Type	Function	Enclosure	Performance
Differential Pressure Indicating Transmitter (Fischer & Porter)	Electronic	200 psig static pressure limit, DC input from receiver	Cadmium plated steel, stainless steel diaphragm, 3-valve stainless steel bypass manifold, 1/2" NPT connections	$\pm 0.25\%$ accuracy of span over 8:1 range, $\pm 0.25\%$ drift of reference span in 6 months, 500 MHzRFI protection to 5 watts
Indicators (Fischer & Porter)	Electronic or diaphragm, 4" digital or window display	0-200 PSIA or 4-20 mADC (10-ohm term. resist.) input	4" to 6" case; flush, surface or conduit mtg.	$\pm 2\%$ accuracy
Flow Element-Magnetic Meter (Fischer & Porter)	Pulsed DC; self-cleaning, field re-placeable stainless steel electrodes	1 watt/5 mm diameter max power use	Epoxy coated, polyurethane lined steel body; epoxy potted coils; 150-lb steel flanges	$\pm 0.5\%$ rate accuracy
Flow Indicating Transmitter - Magnetic Meter (Fischer & Porter)	Remote electronics	Pulsed DC input from flow element	Waterproof; pipe bracket or wall mtg.	$\pm 0.5\%$ rate accuracy
Electrode Cleaner (Fischer & Porter)	Automatic cyclic cleaning	45-65 KHz output, 100 MS pulse duration, 60 or 20 pulses/min rate	Steel case	_____
Flow Relay - Zero Return Unit (Fischer & Porter)	External contact actuated	External dry contact closure during no-flow	_____	_____
Flow Element - Transit Time Ultrasonic (Badger)	Dual element, Piezo wetted sensor	0.1-100 ft/sec flow range	Hot tap comb. sensor/valve mtg., PVC armored coaxial sensor cables	$\pm 1.5\%$ accuracy
Flow Indicating, Totalizing Transmitter (Badger)	Transit time; micro-processor based	Local liquid crystal display	_____	$\pm 0.5\%$ accuracy
Level Indicating Transmitter (Rosemount)	Pressure actuated	200 psig pressure limit, independent span and zero adjustments, integral range elevation and suppression adjustments	Stainless steel body and wetted parts, 1/2" NPT connections	$\pm 0.5\%$ transmitter accuracy, $\pm 2\%$ indicator accuracy
Level Element-Bubbler System (Healy-Ruff)	Constant differential, dual air compressors	Air supply exceeds maximum head; 50 psig compressor operating press., 1.4 cfm free air capacity	Brass, stainless steel or neoprene regulator; comb. filter/pressure regulator air set; stainless steel rotameter	$\pm 2\%$ accuracy
Pressure Indicating Switch (Mercoind)	SPDT, manual reset	10 amp to 120 VAC contact rating, 3-10% av. switch differential	Case 6" \pm , white face dial with black nos.	_____
Pressure Indicating Transmitter (Fischer & Porter)	Diaphragm	200 psig static pressure limit, DC input from receiver	Stainless steel body and wetted parts	$\pm 0.5\%$ transmitter accuracy, $\pm 2\%$ indicator accuracy
Diaphragm Seal - Flange Mounted (Red Valve Co.)	Sensing Liquid and sleeve	360° Buna-N sleeve, silicone oil	Steel body, ANSI 125-lb flanges, 1/4" NPT connection	_____
Level Switch - Float Type	Mercury	High and low level control	_____	_____

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1019-5.3 Instrumentation Panel: Panel shall be free standing. Interior panels shall be NEMA 1A and exterior panels shall be NEMA 4X. Instrumentation and control panels may be incorporated into motor control center or switchgear. Instrumentation panel shall not have exposed nuts, bolts or screws on exterior locations. Panel exterior shall be painted to match MCC line-up for interior locations. NEMA 4X panels shall not be painted. Interiors of panels shall be painted white.

Accessory devices necessary for a complete system, such as relays, annunciator logic cards or chassis, and signal isolators, shall be provided. Control cabinet shall include necessary annunciator logic and status-alarm lights, instruments and hand switches.

Access doors shall have continuous stainless steel hinges and stainless steel handle with 3-point roller bearing latches. Panels shall be internally braced 11-gage steel. Front panels or sections containing instruments shall be reinforced 7-gage steel or 1/4" anodized aluminum. Sections shall be descaled, degreased, filled, ground and finished. Steel enclosures shall be finished with 2 rust-resistant phosphate prime coats and 2 air-dry silicone alkyd finish coats. Colors shall be selected by Owner. Brushed anodized aluminum, stainless steel and FRP Panels will not require a paint finish.

Panel equipment shall be mounted and wired on or within cabinet. Wiring shall comply with the NEC. Wiring within panel shall be grouped with harnesses or ducts and secured to structure. Wiring shall be numbered in accordance with wiring/connection diagrams. Wiring and connection diagrams shall conform to ISA S5.4 and shall be submitted for approval.

Power and low voltage DC signal wiring shall be routed in separate wireways. Wires shall cross at right angles. Parallel troughs of different systems shall be separated by at least 12". Power wire shall be No. 16 AWG type THWN stranded, insulated for not less than 600 volts. Wire color shall be: Line Power - Black; Neutral or common - White; AC Control - Red; DC Control - Blue; Equipment or Chassis Ground - Green; specified externally powered circuits - Orange. Graphic light wiring (24 volt maximum) at lamp socket may be No. 22 AWG if properly fused, protected and terminated in a terminal block capable of accepting No. 14 AWG wiring.

Wiring shall terminate in a master terminal board, which shall be rigid type and numbered. Master terminal board shall have at least 25% spares. Terminal blocks shall be arranged in vertical rows and separated into groups. (Power, AC control, DC signal, alarm, and graphic.) Terminal blocks shall be barrier type with appropriate voltage rating (600V minimum) and shall be raised channel mounted.

Wiring trough for supporting internal wiring shall be plastic with snap-on covers. Side walls shall be open-top to permit wire changing without disconnecting. Wire connectors shall be hook fork type with non-insulated barrel for crimp type compression connection to wire. Wire and tube markers shall be sleeve type with heat impressed letters and numbers. Terminal strips shall be provided for connecting control and signal wiring.

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Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. Field wiring side of terminal shall be separated at least 6" from side panel or adjacent terminal. Wiring troughs shall not be filled more than 60%. Wiring trough covers shall be match-marked to identify placement. If component identification is shown on covers for visibility, ID shall also appear on mounting sub-panel.

A plug-in header with convenience outlets and flexible plug-in shall be provided for instrument power supplies. A spare convenience outlet and overhead internal light shall be provided. Front layout shall be submitted for approval.

Wiring to hand switches, etc., which are live circuits independent of panel's normal circuit breaker protection shall be identified as such.

Nameplates shall be provided for flush mounted equipment. Nameplates shall be 1" x 3" black and white laminated phenolic material having engraved letters 1/4" high, extending through white face into black layer. Nameplates shall be attached to panels by pop rivets or self tapping screws of same material as mounting surface.

Storage pockets shall be provided on inside of panel of sufficient size to hold all prints required to service equipment. Reduced size prints may be provided; however, prints must be readable.

Where required for operation, instrument panel shall include strip heaters, ventilating fans, intake louvers and gasket door. Heater voltage shall be twice the line voltage. Heaters and ventilating fans shall be thermostatically controlled. Intake louvers shall be fully baffled with filters. Systems shall be duplex.

1019-5.4 Panel Mounted Instruments: Panel mounted instruments shall be provided in accordance with Table 10-17 herein.

TABLE 10-17

PANEL MOUNTED INSTRUMENTS

Equipment (Manufacturer)	Type	Function	Enclosure	Performance
Flow Integrator (Moore Industries)	8-digit electro-mechanical	24 VDC pulse output, 0-10% adjustable dropout	8" x 12" x 5" maximum case, slide tray	$\pm 0.5\%$ accuracy
Indicator-Bar Graph (Fischer & Porter)	Gas discharge or LED segment array display	Can power 2-wire transmitter loop	3" x 6" case	$\pm 0.5\%$ accuracy
Relay-Signal Converter (Acromag)	_____	DC output	Aluminum case, rear mounting	$\pm 0.25\%$ accuracy
Relay-Add/Subtract (Moore Industries)	_____	Individual adjustable scaling, RFI protection	Rack mounted	$\pm 0.5\%$ accuracy
Relay (Acromag)	SPDT outputs	Dual alarms, adjustable set points	Rack mounted	$\pm 2\%$ accuracy
Indicating Recorder (Fisher & Porter)	Microprocessor based, 10"-12" circular charts	Form C SPDT control switches, chart configurable up to 30-day rotation	15" x 21" x 7" case; flush, wall or pipe mounting	$\pm 0.5\%$ accuracy
Indicating Recorder (Foxboro)	4" strip chart	Form C SPDT control switches, continuous charting for 30 days	6" x 6" x 20" case, flush mounting	$\pm 0.5\%$ accuracy
Indicating Process Controller - PID (Foxboro)	Microprocessor based	4" vertical scale input indication, horizontal scale or digital output indication, auto-manual switch, local-remote switch	3" x 6" x 20" case, slide tray, flush mounting	$\pm 0.5\%$ accuracy

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1019-5.5 Panel Components:

(a) **General:** Components shall be mounted to permit servicing, adjustment, testing and removal without disturbing other components. Components inside of panels shall be mounted on removable plates. Mounting shall be rigid unless shock mounting is required to protect equipment from vibration. Mountings for components shall be oriented in accordance with industry standard practices. Internal components shall be identified with plastic or metal engraved tags attached with drive pins adjacent to each component.

(b) **Push Buttons:** Push buttons shall be Allen-Bradley heavy-duty, oil-tight, with an escutcheon plate, and contacts rated for 10 amps at 120 VAC.

(c) **General Purpose Relays:** Relays shall be Allen-Bradley double pole, double throw, octal plug-in type with a transparent dust cover. Relay shall have a light to indicate when coil is energized 5 amp VAC, and a mechanical life of 10,000,000 operations minimum.

(d) **Timers:** Timers shall be Allen-Bradley plug-in type with dust and moisture resistant case, multi-range/analog or digital type with selectable ranges, between 1 second and 10 hours full scale. Output contacts shall be rated at 2.5 amp 120 VAC minimum. Timer shall have a "timing in progress" indication. Mechanical life shall be 10,000,000 operations minimum.

(e) **Hand Switches:** Switches shall be Allen-Bradley oil-tight rated and shall have on-off-lock off (O-O-L), hand-off-automatic (H-O-A) or off-automatic (O-A) positions.

(f) **Pilot Lights:** Lights shall be Allen-Bradley oil-tight rated lights. Lamp modules shall operate at 120 VAC input.

Lamps shall be replaceable from the front and shall be "push to test" type.

(g) **Run Time Meters:** Meters shall be Allen-Bradley 6-digit, non-reset time meters recording in hours and tenths.

(h) **Intrinsically Safe Relays:** Intrinsically safe relays shall be provided between float switches and other devices located in similar areas as required to meet code requirements. Relays shall be as specified in Subsection 1019-17(c).

(i) **Phase Failure Relays:** Relay shall have adjustable trip delay and adjustable restart delay, and shall automatically reset after time delays expire. Relays shall be as specified in Subsection 1019-17(c).

(j) **Clocks:** Clocks shall be approved digital 24-hour clocks with 2" LCD display.

(k) **Power Conditions:** Incoming power circuit to instrument and control panel shall be protected by a Square D power line conditioner

which shall provide protection against voltage sags and surges and correct voltage fluctuations as large as 25% below nominal in less than 2 cycles of line frequency. Two conditioners, one for each panel, shall be installed inside panel cabinets. Power conditioners shall be rated for a minimum of 1000 VA each, 120 VAC, 60 Hz service.

(1) **Flow Totalizer (Impulse Counter):** Counter shall be flush mounting 6-digit electronic with 1/2" LCD. Unit shall be capable of accepting up to 3000 pulses per minute from an impulse voltage of 6 to 250 volts AC or DC. Counter shall include an internal power source with a rated life of 10 years. Unit shall have a face-mounted lock and key reset. Counter shall be Veeder-Root Model 7997X.

1019-5.6 Annunciator: Annunciator system shall be Panalarm.

White engraved windows in light-boxes shall be provided for visual annunciator off-normal conditions. Red engraved windows shall be provided for emergency annunciation. Annunciator layout shall follow process flow. Cabinets shall include lamp boxes and solid state annunciator logic plug-in alarm cards. Cabinets shall be metal and well-ventilated.

Alarm module shall accept normally open or normally closed field contacts and shall be field-selectable. Lamp modules shall be separate plug-in modules with at least 2 bulbs per alarm point.

Alarm sequence shall be manual reset. An off-normal field contact condition shall initiate a flashing visual signal corresponding to the point in alarm condition and cause an exterior mounted alarm light to flash and an interior sound alarm (low level) to operate at annunciator. Depressing acknowledge push button shall silence interior audible alarm and change annunciator flashing light to a steady light. When off-normal field contact returns to normal, no change in status shall occur. Depressing reset push button shall not affect alarm points that have not returned to normal. Exterior alarm light shall continue to flash until all alarm points are cleared. A test push button circuit shall be included which will flash all alarm lamps and will not activate auxiliary relays used for retransmission of alarms.

Push buttons shall be separately mounted on panel.

Annunciator points shall be supplied with an auxiliary contact output which shall be field-selectable, normally open or normally closed. Auxiliary contact relay shall be an integral part of alarm logic card. Annunciator shall be supplied with a common trouble alarm with normally open or normally closed contacts which shall activate when any point of annunciator is in alarm condition.

Annunciator shall operate from 115v, 60 Hz and be supplied with necessary power supplies to run logic system. Annunciator logic system shall function with the alarm windows or alarm lights as specified.

Annunciator alarm points shall be as follows:

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- (1) Pump off for all pumps and each pump
- (2) Pump failure for each pump
- (3) Air system failure
- (4) PLC failure
- (5) High and low level from PLC
- (6) High and low level from float switches
- (7) High or low suction pressure
- (8) High or low discharge pressure
- (9) Phase failure relay - auto reset

1019-5.7 Telemetry Interface Panel: Telemetry interface panel shall be NEMA 1A for interior locations and NEMA 4X for exterior locations. Painting shall be as specified for instrumentation panel.

Outer door shall have continuous stainless steel hinges and stainless steel handle with 3-point roller bearing latches.

Telemetry interface panel shall be internally separated with metal barriers to house terminal blocks and wiring for alarm output contacts from annunciator and other alarms.

Terminal blocks and wiring for each section shall be as specified for instrumentation panel except that each terminal shall have a 1/2-amp fuse. Provide 25% spare terminals in each section.

1019-5.8 Lighting/Surge Protection:

(a) **General:** Lighting/surge protection shall be provided to protect instrumentation system from induced surges along analog and discrete signal and power supply lines. Protective level shall be lower than instrument surge withstand level, and be maintenance-free and self-restoring. Instruments shall be housed in a metal case. Ground wires for surge protectors shall be insulated and connected to station grounding system. Protectors shall be mounted within instrument enclosure. Units shall be as manufactured by MCG Electronics Inc.

(b) **Power Supply:** Cabinets or panels and groups of field instruments shall be protected by isolation transformers and surge suppressors. Individual field instruments shall be protected by gas tube surge suppressors.

(c) **Signal Lines:** Protection devices shall be installed at both ends and as close to instrument being protected as possible. Where signal lines enter control rooms through an interface cabinet, protection devices shall be mounted in interface cabinet. Protection shall be with combined use of gas tube surge arrestor and Zener diode protectors.

1019-6 PIPING:

1019-6.1 Steel Pipe: Pipe shall be galvanized Schedule 40 steel pipe conforming to ASTM A 53, Type E, Grade A, with threaded ends.

Joints shall be made up with either a graphite/mineral oil mixture or nontoxic, nonharding pipe joint compound.

Exposed threads and damaged coating shall be painted with Koppers Bitumastic Paint.

Flanged connections shall be made up with threaded galvanized steel nipples and threaded 150 psi ANSI flat face flanges.

Flanges, bolts, nuts and gaskets shall conform to AWWA C 207, Class D, 150 psi pressure rating.

Pipe sleeves for wall and floor penetrations shall be galvanized steel pipe conforming to ASTM A 53. Cut ends shall be smoothed and coated with Koppers Rust Inhibitive Primer.

1019-6.2 Ductile Iron Pipe:

(a) **General:** Pipe shall be Class 53 thickness conforming to ANSI A 21.15. Exposed piping shall be painted with 1 coat of Koppers No. 621 Rust Inhibitive Primer; all other piping shall be painted with 1 coat of Koppers Bitumastic 300M coal tar enamel to a minimum dry film thickness of 16 mils.

(b) **Flanged Pipe:** Flanges and fittings shall conform to ANSI A 21.10, 150 psi pressure rating. Bolts and nuts shall conform to ASTM A 307, Grade B. Gaskets shall be full faced of rubber with cloth insertion; and shall be 1/16" thick for pipe less than 12" diameter, and 3/32" for larger size pipe. Flange fillers shall be Clow Figure F-1984, and beveled flange fillers shall be Clow Figure F-1986.

(c) **Mechanical Joint Pipe:** Pipe shall be as specified for flanged pipe except joints shall conform to ANSI A 21.11.

(d) **Flexible Couplings:** Pipe for split couplings shall have radius grooved ends.

1019-6.3 Plastic Pipe: Pipe shall be polyvinyl chloride (PVC) pipe conforming to Subsection 1016-2.4. Fittings shall conform to ASTM D 2467. Flange bolts and nuts shall be stainless steel, and gaskets shall be 1/8" thick full-faced gaskets.

1019-6.4 Hangers and Support: Metal hangers and supports shall be galvanized.

(a) **Metal Pipe:** Hangers and supports shall be placed at maximum 10' intervals.

(1) **Wall or Column Supports:** Pipe shall be supported by Grinnell Figures 194, 195 or 199 steel brackets. Pipe above brackets shall be secured by anchor chair and U-bolts for smaller pipe. Anchor chairs shall be Carpenter & Patterson Figure 127, and U-bolts shall be Grinnell Figure 120 and 137. Pipe below brackets shall be supported by pipe hangers suspended from brackets by steel rods.

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(2) **Floor Supports:** Pipe shall be supported by either saddles or cast-in-place concrete. Concrete edges shall be beveled 1". Pipe shall be secured to concrete support with metal anchor straps. Saddle supports shall be Grinnell Figure 264.

(3) **Vertical Supports:** Pipe shall be secured by Grinnell Figure 262 pipe clamps.

(b) **Plastic Pipe:** Single pipes shall be supported as specified for metal pipe, except at 5' maximum intervals. Multiple horizontal pipes and rubber hoses shall be supported by Husky-Burndy Electray Ladder. Pipe shall be secured to ladder with Husky-Burndy Model SCR fasteners at 9' maximum intervals.

1019-7 VALVES AND APPURTENANCES: Valves shall have manufacturer's name and pressure rating cast in raised letters.

1019-7.1 Gate Valves:

(a) **Valves Less Than 4":** Valves shall be Fairbanks No. 0280.

(b) **Valves 4" Thru 12":** Valves shall be NRS valves conforming to AWWA C 509 with o-ring seals, as manufactured by Mueller Company.

(c) **Valves More Than 12":** Valves shall be NRS valves conforming to AWWA C 500 with solid-wedge gates, o-ring seals and flanged ends, and shall open counterclockwise.

(d) **Buried Valves:** Buried valves shall have mechanical joint ends and 3-piece cast iron valve boxes. Box shall have a 2-piece sliding barrel with 5 1/4" shaft. Upper section shall have a flanged bottom and cast iron cover with the word "SEWER" cast in raised letters. One T-handle wrench shall be provided with each valve. Boxes not in pavement shall be set in a 4" thick, 2' square concrete slab.

1019-7.2 Plug Valves: Valves shall be nonlubricated eccentric type with resilient faced plugs as manufactured by Val-matic. Valves shall be tested in accordance with AWWA C 504. Pressure rating shall be 175 psi for less than 14" valves, 150 psi for valves 14" thru 36", and 125 psi for valves over 36".

Flanges shall be faced and drilled to ANSI 125/150-lb standard; mechanical joint ends shall conform to AWWA C 100, Class B; and threaded ends shall be NPT.

Body shall be cast iron conforming to ASTM A 126, Class B. Port area shall be 80% of nominal pipe area for valves less than 24", and 70% of nominal pipe area for 24" or larger valves. Exposed hardware shall be zinc or cadmium plated. Plug facings shall be Hycar or neoprene.

Plug stem bearings shall be permanently lubricated stainless steel. Seats in 4" or larger valves shall have a high nickel content overlay on plug face contact surfaces. Shaft seals shall conform to AWWA C 507.

Actuators shall conform to AWWA C 507. Valves 6" or larger shall have gear actuators enclosed in an ASTM A 126, Class B cast iron housing.

3-way plug valves shall be nonlubricated gear oriented. Body shall be ASTM A 126, Class B cast iron with 125-lb flanges. Plugs shall be resilient faced. Valves shall be 3-port, 270° turn.

Buried valves shall have valve boxes as specified in Subsection 1019-7.1 (d) and shall have a remote position indicator in valve box showing position of valve. A stainless steel or aluminum centering and I.D. plate shall be provided showing direction of opening and number of turns to open for each valve.

Buried or submerged valves and actuators shall have sealed shafts and watertight gasketed housing covers.

1019-7.3 Check Valves:

(a) **Air Cushion Valves:** Valves shall be pressure rated at 150 psi, of the cushioned swing, nonslam or silent type. Valves shall be Val-matic with cast iron or cast steel bodies, bronze or stainless steel seat ring, noncorrosive shaft for attachment of weight and lever, and complete noncorrosive cushion chamber. Valve must be tight seating and shall operate without hammer or shock. Seat ring shall be renewable and held in place by a threaded joint.

Cushion chamber shall be attached to side of valve body externally and constructed with a piston operating in a chamber that will permit valve to be operated without hammering. Cushioning shall be by air, and cushion chamber shall be so arranged that closing speed will be adjustable.

Valve disc shall be cast iron or cast steel and shall be suspended from a noncorrosive shaft which will pass through a stuffing box and connect to cushion chamber outside valve.

(b) **Swing Valves:** Valves shall be APCO Series 100-1 rubber flapper type with long body, flanged ends and 150-lb pressure rating, and conforming to AWWA C 508.

(c) Ball Valves:

(1) **Ductile Iron Pipelines:** Valves shall be Flowmatic Model 408 and shall conform to AWWA C 507, 450-lb rating.

(2) **PVC Pipelines:** Valves shall be Wallace and Tiernan, Inc. PVC Type 1, Series BC, with union, socket and threaded or flanged ends, as specified.

1019-7.4 Quick Connect Couplings: Couplings shall be Dover Corporation OPW Division Model PF-C coupler with Model 634A plug.

1019-7.5 Air Release Valves: Valves shall be Val-matic Valve and Manufacturing Company Model 48SBWA.

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1019-7.6 Corporation Stops: Corporation stops shall be 3/4" Mueller Company H-15029 for 100 psi test pressure.

1019-7.7 Flange Adapter Couplings: Couplings shall be Dresser Company Style 128, 150 psi pressure rating. Victaulic adapters may be used in lieu of Dresser couplings.

1019-7.8 Flexible Couplings: Flexible couplings shall be either split type or sleeve type.

Split couplings shall be used with interior piping and, when specified, with exterior piping. Couplings shall be mechanical type for radius groove piping. Couplings shall mechanically engage and lock grooved pipe ends in a positive couple and allow for deflection, contraction and expansion.

Couplings shall consist of ASTM A47, Grade 32510 iron housing clamps in 2 or more parts, a chlorinated butyl composition sealing gasket with a "C" shaped cross-section and internal sealing lips projecting diagonally inward, and 2 or more oval track head bolts with hexagonal nuts conforming to ASTM A 183 to assemble clamps.

Victaulic type couplings may be used in lieu of flanged joints. Pipes shall be radius grooved as specified for use with couplings. Flanged adapter connections shall be Victaulic Vic Flange Style 741.

Sleeve couplings used with buried piping shall be Dresser Style 38 with cadmium-plated steel bolts and nuts. Couplings shall be furnished with pipe stop removed and gaskets of a composition suitable for exposure to domestic sewage.

1019-7.9 Diaphragm Seals: Diaphragm seals shall be installed on pressure gage or pressure switch connections where specified. Seal shall be thread attached to piping and pressure sensing devices. Seals shall be cadmium plated carbon steel, except for lower housing which shall be designed according to pressure being monitored. Seals shall have a flushing connection and be Mansfield and Green Type SB.

Full circle sensing seals that insert between adjacent pipe flanges, such as Red Valve Company Series 40 Flanged Sensor, may be used in lieu of seal specified above. If this seal is used, the pressure sensing device shall be factory installed on the seal.

1019-7.10 Unions: Unions for pipe less than 2 1/2" shall be galvanized malleable iron, 150-lb class. Unions for 2 1/2" or larger pipe shall be flange pattern, galvanized, 125-lb class. Unions shall be gasketed.

1019-7.11 Mechanical Wall Seals: Seals shall consist of an adjustable modular bolted, synthetic rubber and plastic sealing element. Sealing element shall be Thunderline Corporation Link-Seal. Hardware shall be for corrosive service. Sleeves for use with seals shall be Schedule 40 steel pipe with waterstop approximately 2" wide and 1/4" thick welded around periphery of pipe and galvanized.

1019-7.12 Hose End Faucets: Faucets for potable water shall be Zurn Model Z-1385 with removable key.

1019-7.13 Pressure Gages: Each pressure gage shall be direct mounted, fiberglass reinforced polypropylene case, glycerine filled, with a 4 1/2" diameter dial with a clear acrylic window, 3/8" shut-off valve, and a bronze pressure snubber. Provide diaphragm seals between shut-off valve and pressure gage on lines with nonclear matter in suspension or solution. Gages shall be weatherproofed. Face dial shall be white finished aluminum with black graduations and figures and shall be dual scale (psi and ft of H₂O).

Each suction or discharge line shall have H.O. Trerice Company Series 450 gages of minimum sizes as follows with changes required by pump shutoff head shown on pump station data table for each installation:

<u>Pump</u>	<u>Suction</u>	<u>Discharge</u>
Centrifugal	-15 (-35) to 15 (35) psi (ft)	0 to 60 (138) psi (ft)
Submersible	_____	0 to 60 (138) psi (ft)

1019-7.14 Reduced Pressure Backflow Preventers: A Model FRP 11 or 6 CM backflow preventer shall be provided on potable water supply to pump station, and shall have a strainer and ball type isolation valve.

1019-7.15 Diaphragm and Flap Check Valves: These valves are for use on wet well end of valve pit drain piping. Diaphragm check valves shall be Red Valve Series TF-2 Compression bands for attaching valves shall be stainless steel. Flap valves shall be Clow Figure No. F-3016.

1019-7.16 Shop Painting: Ferrous surfaces of valves and appurtenances (except stainless steel, galvanized or cadmium plated surfaces) shall be coated with a rust-inhibitive primer. Pipe connection openings shall be capped prior to painting.

1019-8 MISCELLANEOUS ELECTRICAL EQUIPMENT:

1019-8.1 Enclosures: Interior enclosures shall be NEMA 1 and exterior enclosures shall be NEMA 4; however, NEMA 4 X and 7 enclosures shall be used when specified.

NEMA 4 and 4X enclosures shall be stainless steel; NEMA 7 enclosures shall be cast iron.

1019-8.2 Disconnect Switches: Switches shall be Square D Company heavy-duty, quick-make, quick-break, visible blades, 600-volt, 3-pole with full cover interlock. Exterior switches shall have copper lugs.

1019-8.3 Motor Starters:

(a) **Manual Motor Starters:** Starters shall be Square D Company nonreversing, reversing or 2-speed type, as specified, for single-phase motors.

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(b) **Magnetic Motor Starters:** Starters shall be Square D Company, 2- or 3-pole, single- or 3-phase, 60 Hz, 600-volt, magnetically operated, full voltage nonreversing. Single or 2-winding motors shall have 2-speed starters.

Starter shall have 120-volt operating coil and control transformer; 3-phase starters shall have 3 overload relays. Auxiliary contacts shall be provided as specified or required for control sequencing. At least 1 set of spare N.O. and N.C. auxiliary contacts shall be provided.

Overload relays shall be adjustable, ambient temperature compensated and manually resettable. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses. Built-in control stations and indicating lights shall be furnished when specified.

(c) **Combination Magnetic Motor Starters:** Starters shall be as specified in Subsection 1019-16(e).

1019-8.4 Control Stations: Stations shall be Square D Company Class 9001, heavy-duty, with full size operators. Enclosures shall have a chain and pin for locking out the stop button.

1019-8.5 Transformers: Transformers shall be dry type, 2-winding with KVA and voltage ratings, single- or 3-phase as specified. At least 4 full capacity primary winding taps shall be provided, at 2 1/2% and 5% above and below rated primary voltage. Maximum temperature rise shall be 115°C.

(a) **General Purpose:** Transformers shall be by General Electrical Company and conforming to ANSI C 89.2 and NEMA ST-20.

(b) **Noise Isolation:** Transformers shall be General Electric Company Guard II, and shall have electrostatic shielding and spike suppression.

1019-8.6 Automatic Transfer Switch: Switch shall be provided for dual service installation and shall be as specified in Subsection 1019.16(e).

1019-8.7 Unit Heaters: Heaters shall be E. L. Wiegand Company Chromalox Type LUH and thermostats shall be Chromalox Type MHT-473E-1017.

Heaters shall be designed for 208, 240 or 480-volt, single-phase/3-wire or 3-phase/4-wire operation with specified KVA rating. Heaters shall have adjustable swivel brackets, and elements shall be metal sheath Fintube with built-in overload protection.

Fan motor shall be operated from single or 3-phase supply. Motors shall be totally enclosed, NV or FC, 208, 227, 240 or 480-volt, single or 3-phase, rated for continuous operation with built-in overload protection. A thermostat shall be furnished with each heater.

1019-8.8 Lightning Arrestors and Surge Capacitors:

(a) **Lightning Arrestor:** General Electric Company Catalog No. 9L15ECC001, 650-volt, 3-phase, Tranquell type.

(b) **Surge Capacitor:** General Electric Company Catalog No. 9L18BAB301, 650-volt, 3-phase, nontoxic liquid insulated.

1019-8.9 Wireways: Square D Company steel Square-Duct.

1019-8.10 Manual Transfer Switches: Switches shall be General Electric Company Style A, heavy-duty, 120/208, 120/240 or 277/480-volt, double-throw, quick-make, quick-break. Switches shall be interlocked where specified.

1019-8.11 Control Relays: Relays shall be Square D Company CR 122A, heavy-duty machine tool type with 10-amp, 300-volt convertible contacts. Time delay relays shall be adjustable from 0.2 to 180 seconds.

1019-8.12 Limit Switches For Check Valves: Switches shall be Mercoid, hermetically sealed, with oil-resistant cable attached and sealed and terminating in junction box with a CGB connector. Supply conduit for switch shall terminate in a cast iron junction box within 18" from switch, and junction box shall be filled with paraffin after operation tests.

1019-8.13 Pressure Switches and Diaphragm Seals: Switches for discharge header shall be Mercoid Model DA 31153-7 with 1 normally open and 1 normally closed contact with single set point adjustable from 5 to 150 psig, and with a connection for 1/2" threaded conduit.

Diaphragm seals shall be as specified in Subsection 1019-7.9.

1019-9 WIREWAYS:

1019-9.1 Rigid Steel Conduit: Rigid steel conduit shall conform to ANSI C 80.1 or C 80.5, and shall be used as wireways for shielded process instrumentation wiring and shielded control wiring, except where cable tray is specified.

1019-9.2 Plastic Conduit: Conduit shall be Carlon rigid polyvinyl chloride (PVC), Schedule 80. PVC conduit shall not be used in exposed locations.

1019-9.3 Flexible Metal Conduit: Conduit shall be Anaconda Sealtite Type UA. Fittings shall be Crouse Hinds Company screw-in type.

1019-9.4 Boxes:

(a) **Switch and Outlet Boxes:** Exposed boxes shall be Crouse-Hinds Company Type FD, cast or malleable iron. Box and fittings shall have cadmium-zinc finish, threaded conduit connections, cast cover and stainless steel screws.

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Concealed boxes shall be Adalet Company galvanized pressed steel.

(b) **Terminal Junction and Pull Boxes:** Boxes shall be Hoffman Engineering Company continuously welded galvanized steel. Box shall be 14-gage and covers 12-gage steel, with flanges and no holes or knockouts. Connections shall be made by conduit hubs.

1019-9.5 **Fittings and Seals:**

- (a) **Elbows and Couplings:** Elbows and couplings shall be galvanized steel.
- (b) **Conduit Hubs:** Hubs shall be by Myers Electric Products, Inc.
- (c) **Expansion/Deflection Fittings:** Fittings shall be Crouse-Hinds Company Type XD.
- (d) **Conduit Sealing Bushings:** Bushings shall be OZ/Gedney Type CGB.
- (e) **Conduit Seals:** Seals shall be Crouse-Hinds Company Type EYS.
- (f) **Drains and Breathers:** Drains and breathers shall be Crouse-Hinds Company Type ECD.
- (g) **Mountings:** Hangers, rods, backplates, beam clamps and other mounting devices shall be Appleton Electric Company galvanized iron or steel.
- (h) **Wall and Floor Penetration Seals:** Openings shall be sealed with Thomas and Betts Company Flame-Safe.

1019-10 **WIRES AND CABLES:**

1019-10.1 **Wire and Cable (600-Volt or Less):** Wire and cable shall be annealed, 98% conductivity, soft drawn stranded copper. Wire smaller than AWG No. 12 shall not be used, except for control, signal and instrumentation circuits. Wire sizes and types shall be as follows:

<u>Circuits</u>	<u>Wire Type</u>
AWG No. 10 & smaller	THHN/THWN
AWG No. 8 & larger	USE
Control, AWG No. 14	THHN/THWN
Instrumentation, Potentiometer, & RTD, AWG No. 16	Twisted & Shielded
Ground Wire	THW, Green

- (a) **Types THHN/THWN, THW and USE:** These shall be by Collyer Insulated Wire Company.
- (b) **Control Cable:** Multi-conductor control cable shall be Cerro Wire and Cable Company Firewall
- (c) **Instrumentation Cable:** Cable shall be Belden Catalog No. 9342.

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(d) **Signal Cable:** Potentiometer and RTD cable shall be Belden Catalog No. 8618.

1019-10.2 Wire Splice Insulators: Insulators shall be 3-M Company PST Cold Shrink.

1019-10.3 Markers: Wire and cable markers shall be W. H. Brady Company Omni-Grip or preprinted, self-adhesive vinyl tapes.

1019-10.4 Fireproofing Tape: Tape shall be Scotch No. 77 with No. 27 binding.

1019-10.5 Warning Tape: Direct buried cable warning tape shall be W. H. Brady Company Type B-720.

1019-11 MOTORS:

1019-11.1 Rating: Motors shall be rated as follows:

<u>Horsepower</u>	<u>Rating</u>
Below 1/2	115/230V, 1-phase, 50 Hz AC
1/2 thru 25	200 V, 3-phase, 60 Hz Ac for 120/208V service; and 230/460 V, 3-phase, 60 Hz Ac for 240/480 V or 277/480V, 3-phase service
Above 25	230/460 V, 3-phase, 60 Hz AC

1019-11.2 Construction: Squirrel-cage rotors shall be made from high-grade steel laminations fastened together and to the shaft, or shall be cast aluminum or bar-type construction with brazed end rings.

Motors 15 hp and larger shall have an efficiency of 85% (minimum) at full load and high speed. Motors 25 hp and larger shall have a 120-volt space heater for moisture control.

1019-11.2.1 Low-Voltage, 3-Phase Motors: Motors shall be by Reliance and shall be squirrel-cage or wound rotor induction type, as specified.

Motors shall have normal or high starting torque (as required), low starting current (not to exceed 600% full load current), and low slip.

Motors shall be totally enclosed fan-cooled construction with 1.15 service factor, and suitable for operation in moist air with hydrogen sulfide gas present. Output shaft shall be suitable for direct connection or belt drive as required.

Motors shall have a Class B, non-hygroscopic insulation system. Class F insulation may be used, but shall be limited to Class B temperature rise.

Motors shall have a chemical resistant corrosion and fungus protective

epoxy fortified enamel finish over red primer on all interior and exterior surfaces. Stator bore and rotor of motors shall be epoxy coated. Fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads. Machine surfaces shall be coated with rust inhibitor.

Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed. Motors shall have condensate drain hole and epoxy coated motor windings to protect against moisture.

Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on motors with frames 254T and larger.

(a) **Fractional Horsepower Motors:** Motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight die-cast aluminum. Windings shall be varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment. Motor shaft shall be high-grade, cold-rolled shaft steel with drive-shaft extensions machined to standard NEMA dimensions for the particular drive connection.

For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position. For heavy loading, bearings shall be precision ball bearings with extra quality, long-life grease, and large reservoir providing 20 years normal operation without relubrication.

(b) **Integral Horsepower Motors:** Motor frames and end shields shall be cast iron or steel of such design as to hold motor components in proper position and provide adequate protection for the type of enclosure employed.

Windings shall be insulated and braced to resist failure due to electrical stresses and vibrations.

Shaft shall be machined steel or steel forging of size and design to withstand stresses normally encountered in motors of the particular rating. Bearing journal shall be ground and polished.

Rotors shall be made from steel laminations fastened together, and to the shaft. Rotor squirrel-cage windings may be cast-aluminum or bar-type construction with brazed end rings.

Motors shall have vacuum-degassed anti-friction bearings of ample capacity for motor rating. Bearing housing shall be large enough to hold sufficient lubricant to minimize need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. Bearing housing shall have long, tight, running fits or rotating seals to protect against entrance of foreign matter into bearings, or leakage of lubricant out of bearing cavity. Bearings shall have a minimum B-10 life rating of 5 years.

Stator windings shall be copper.

(c) **Low-Voltage, 1-Phase Motors:** Single-phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the specified rpm. Motors shall be totally enclosed fan cooled, with temperature rise in accordance with NEMA Standards for Class B insulation. Motors shall be designed for severe duty and operation in moist air with hydrogen sulfide gas present.

Motors shall have corrosion and fungus protective finish on internal and external surfaces. Fittings shall have a corrosion protective plating. Mechanical characteristics shall be the same as specified for poly-phase fractional horsepower motors.

1019-12 PANELBOARDS: Panelboards shall comply with UL, NEMA and NEC standards.

1019-12.1 NEMA 1 Panelboards:

(a) **Interiors:** Interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. Wire connectors, except screw terminals, shall be anti-turn solderless type suitable for copper wire of the specified sizes.

Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing main bus connectors, and that circuits may be changed without machining, drilling or tapping.

Branch circuits shall be arranged using double row construction except when narrow column panels are specified. Branch circuits shall be numbered by the manufacturer.

A nameplate shall be provided listing panel type, number of circuit breakers and ratings.

(b) **Buses:** Bus bars for mains shall be copper. Full size neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of branch circuit devices. Busing shall be braced to conform to industry standard practice governing short circuit stresses in panelboards. Phase busing shall be full height without reduction. Cross connectors shall be copper. Neutral busing shall have a lug for each outgoing feeder requiring a neutral connection.

Spaces for future circuit breakers shall be bused for the maximum device that can be fitted into them. Full size copper ground bus shall be included.

(c) **Boxes:** Recessed boxes shall be galvanized code gage steel having multiple knockouts. Surface mounted boxes shall be painted to match trim. Boxes shall provide a minimum gutter space of 4" on all sides. Surface mounted boxes shall be field punched for conduit entrances. At least 4 interior mounting studs shall be provided.

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(d) **Trim:** Hinged doors covering circuit breaker handles shall be included in panel trims. Doors shall have a semi-flush type cylinder lock and catch, except that doors over 48" in height shall have a vault handle and a 3-point catch with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock; locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

Trims shall be fabricated from code gage sheet steel.

Exterior and interior steel surfaces of panelboard shall be cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. Finish paint shall be of a type to which field applied paint will adhere.

Trims for flush panels shall overlap box by at least 3/4" all around. Surface trims shall have same width and height as box. Trims shall be fastened with quarter turn clamps.

(e) **Manufacturer:** Panelboards shall be the following type manufactured by General Electric Company.

	<u>Type</u>
120/240V, 1-phase, 3-wire and	NLAB
120/208V, 3-phase, 4-wire	NHB
277/480V, 3-phase, 4-wire	CCB
480V, 3-phase, 3-wire	

1019-12.2 NEMA 3, 4 and 12 Panelboards:

(a) **Interiors and Buses:** Interiors and buses shall be as specified for NEMA 1 panelboards in Subsection 1019-12.1.

(b) **Boxes:** Boxes and covers shall be stainless-steel with natural finish, bolted together and gasketed. Conduit openings shall be tapped.

(c) **Manufacturer:** Panelboards shall be Crouse-Hinds Company Type DVP or DHP, as required by voltage application.

(d) **Circuit Breakers:** Panelboards shall have circuit breakers with the specified frame size and trip settings. Breakers shall be molded case, bolt-in type. Breakers for 120/208V and 120/240V panelboards shall have an interrupting capacity required for the application, but not less than 10,000 amperes, RMS symmetrical.

Single-pole breakers for 277/480V panelboards shall have an interrupting capacity required for the application, but not less than 14,000 amperes, RMS symmetrical.

(e) **Ground Fault Circuit Interrupter (GFCI):** GFCI shall be provided for circuits where specified. GFCI units shall be 1-pole, 120-volt, molded case, bolt-on-breakers, incorporating a solid state

ground fault interrupter circuit installed and isolated from breaker mechanism. The unit shall be UL listed Class A, Group device (5 milliamp sensitivity, 25 millisecond trip time), and a minimum interrupting capacity of 10,000 amperes RMS.

1019-13 UNDERGROUND ELECTRICAL SYSTEM:

1019-13.1 Wireways: Wireways shall be concrete encased, and shall be either PVC or galvanized rigid steel conduit.

1019-13.2 Appurtenances: Cable racks, supports, pulling-in irons and hardware shall be Line Materials Company galvanized steel.

1019-13.3 Manholes and Handholes: Manholes and handholes shall be designed for Class H20 load.

1019-13.4 Ground Rods and Plates: Ground rods shall be Copperweld 3/4" x 10' copper. Grounding plates shall be at least 1/4" x 24" x 24" copper.

1019-14 480-VOLT SWITCHGEAR: Switchgear shall be General Electric Company drawout-type, insulated case, to control 1 or 2 incoming utility lines with 1 tie breaker and feeder breakers as specified. Equipment shall be housed in free-standing NEMA 1A or 3R gasketed enclosures, and shall be UL labeled.

1019-14.1 Protective Devices Coordination: A complete coordination study, including phase-to-phase and ground faults for coordinating all elements of the distribution system, shall be furnished by the manufacturer. The coordination shall provide selective tripping between main, feeder, and downstream breakers and equipment such as variable frequency drivers.

All protective circuit breakers, devices, relays and associated equipment shall be factory set and field tested in accordance with the coordination study. All instrument transformer ratios, circuit breaker and relay curve trip characteristics shall be specified in the coordination study.

1019-14.2 Operation:

(a) **Single Main:** Phase and ground fault overcurrent operations of any circuit breaker shall cause that breaker to open and lockout. Automatic and mechanical reclosing shall be prevented until controls are manually reset. Phase failure or reversal of electrical service shall cause main breaker to automatically open after an adjustable time delay. Upon restoration of power, main breaker shall automatically close after an adjustable time delay.

(b) **Dual Main With Bus Tie:** Under normal conditions, Mains No. 1 and No. 2 breakers are to be closed and the bus tie breaker is to be opened. Under no condition shall it be possible to close all 3 breakers at the same time.

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Phase and ground fault overcurrent operations of any circuit breaker shall cause associated main breaker to open after an adjustable time delay. If power exists on the second main, bus tie breaker shall automatically close after an adjustable time delay. Restoration of power shall cause bus tie breaker to automatically open after an adjustable time delay and close main breaker automatically after an adjustable time delay.

When power is lost on both electrical services, both main breakers shall open automatically and bus tie breaker shall remain open. Upon restoration of power to either source, normal sequence of operations shall occur. Should power return to each of the 2 electrical services at the same time, bus tie breaker shall remain open.

A selector switch shall be provided to modify dual feed automatic operation as follows:

- (1) Position Main No. 1 shall alter automatic operation such that Main No. 1 and bus tie breakers are normally closed and Main No. 2 is normally open. If power to Main No. 1 fails, Main No. 1 shall open after an adjustable time delay. If power to Main No. 2 is proper, Main No. 2 shall close automatically after an adjustable time delay. When power to Main No. 1 is returned to normal, system shall automatically transfer load back to Main No. 1 after an adjustable time delay.
- (2) Position Off shall prevent automatic operation entirely, except that main breakers shall open on loss of proper service.
- (3) Position Normal shall cause automatic system to operate as described above.
- (4) Position Main No. 2 shall be similar, but reversed from that described in (1) above.

Interlocks and time delays shall be provided to prevent restart of pump motors after power outages until motors have stopped and associated automatic valves have closed. If pump motor starts per hour exceed motor ratings, pump motor shall be locked out and alarm contacts shall be provided to indicate such, locally and remotely.

1019-14.3 Rating: Switchgear shall be designed for 480-volt, 3-phase, 4-wire, wye, 60 Hz service and a minimum short circuit rating of 65,000 amps symmetrical. Short circuit rating shall be increased as dictated by Protective Devices Coordination Study.

1019-14.4 Construction: Switchgear shall be single or double-ended, NEMA Class III switchboards with individually mounted, insulated case circuit breakers.

Switchboards shall be Square D Company Power style switchboard with Type SE breakers for mains and bus tie. Branch circuit breakers shall be Square D Type ME, NE or PE as required for loads served and fault currents available.

Switchgear shall be a completely assembled unit of self-supporting construction. Each switchboard shall be a free standing structure of bolted construction to rigidly support devices and equipment. Sides shall be screw-on code gage steel pan-type construction. Distribution protective devices shall be individually mounted with front hinged cover plates and necessary buses and straps shall be provided. Load terminal of feeder devices shall be extended to the rear so that it will be unnecessary to reach across or beyond a line bus to make connections. Removable insulation boots shall be provided to insulate cable connections after feeder cables are installed.

Devices shall be isolated between sections by vertical steel barriers.

Vertical bus shall be so arranged as to have insulating barriers interposed between phases to inhibit phase-to-phase faults. Protective devices shall be compartmentalized by barriers above and below each device to minimize fault communication.

Protective devices shall be arranged so they are individually removable and readily interchangeable from front of switchboard. Rotary operating handles for protective devices shall be of the same design and shall be prominently labeled to indicate device ampere ratings, and color coded for device type. ON-OFF indication shall be shown on prominent markings and handle position.

Live buses shall be phase-isolated in the rear to prevent accidental contact with buses when making up load terminations. Vertical buses shall be isolated from main buses with full length glass polyester barriers. Main buses shall be phase-isolated from each other and from device load lugs by means of isolating barriers. Joint bolts in isolated bus system shall be insulated but maintainable without removal of barriers. Insulation and isolation shall be designed to reduce entrance of foreign objects and contaminants, yet facilitate inspection and maintenance.

Bus bars shall be 98% conductivity copper with a current density of 1,000 amperes per square inch. Surfaces shall be tin-plated by the Alstan 70 (or comparable) process to have a uniform appearance, free of blisters. Bus structure shall be braced to withstand stresses of a short circuit of 65,000 amperes rms symmetrical minimum at load terminals of feeder device, and shall be mounted on supports of high impact nontracking insulating material. Bus bars shall be uniformly arranged to provide A-B-C sequence left to right (from front), front to rear and top to bottom.

A ground bus shall be provided running full length of switchboard, bolted to each vertical section.

Hardware on conductors shall be zinc or cadmium plated and have a minimum tensile strength of 120,000 psi.

Switchgear shall be provided with adequate means for lifting, and be capable of being moved into position and bolted to floor without use of floor sills.

Steel surfaces shall be chemically cleaned and painted with a coat of ANSI No. 61 light gray enamel.

(a) **Main and Bus Tie Breakers:** Breakers shall be insulated case construction with interrupting ratings of 65,000 amps (minimum) at 480-volts, symmetrical. Breaker shall have temperature-insensitive integrally-mounted solid-state sensors, power supply, and trip coil, provided with adjustable, long-time and instantaneous trip settings, interpole phase barriers with manual trip button and position indicator. Trip button shall also permit mechanical simulation of overcurrent tripping for test purposes. Operating mechanism shall be electrically operated, stored energy type to provide quick-make, quick-break operation. Breakers shall conform to NEMA and UL standards and shall be Square D Company, Type SE.

Breaker shall include adjustable short-time and long-time delay trip, integral and adjustable ground-fault trip, key interlock, bell alarm with remote alarm contacts, and trip indicating targets with remote alarm contacts.

Breaker shall be mounted in a drawout mechanism to disconnect breaker from energized bus by means of lever. Mechanism shall have 4 positions:

Engaged, Test, Disengaged, and Fully Withdrawn. When breaker is closed, mechanical interlocks shall prevent moving breaker out of engaged position or moving breaker into or out of test position. Auxiliary contacts shall be provided on breakers to interlock with each other as specified.

(b) **Branch Circuit Breakers:** Breakers shall be insulated case construction with interrupting ratings of 65,000 amps minimum at 480-volts, symmetrical. Breakers shall include shunt trip, ground fault trip, auxiliary switches, alarm switches, cylinder lock, zone selective interlocking function, and adjustable short-time, long-time, instantaneous and ground fault pickup and delay.

(c) **Instrumentation and Metering:** Long-scale switchboard instruments shall be provided, approximately 4 1/4" square, 250° scale, 7.1" long, having $\pm 1\%$ accuracy. Construction shall be Taut-band suspension, black metal case, white dial, with black tapered pointer, and equipped with an external zero adjustment. Ammeter scales shall match CT rating. Voltmeter scale shall be 0-600 volts on low-voltage equipment.

Potential and current transformers shall be of indoor construction with core and coils embedded in a body of noncreep-tracking insulation. CT shall be equipped with over-voltage protecting thyrite resistor.

Current transformers shall be window mounted over bus stubs in circuit breaker compartment to provide for easy access.

Meters shall be semi-flush switchboard type $\pm 1\%$ accuracy.

- (d) **Power Supply Metering:** Sufficient cabinet and bus space shall be provided in each switchgear service entrance compartment for mounting and connecting utility company furnished equipment, such as current transformers, potential transformers and terminal blocks.
- (e) **Miscellaneous Equipment:** Circuit breakers shall be furnished with solid state ground sensors for tripping feeder breakers bus tie and mains.

Selective tripping shall be furnished between mains, ties and feeder circuit breakers. Graphic indication of breaker coordination shall be furnished and the contractor shall demonstrate proper coordination when complete. The manufacturer's field engineer shall set each ground fault device to accomplish the following:

- (1) Feeder breakers shall trip for grounds on load side of breaker.
- (2) Main breaker shall trip for grounds on line side of feeder breaker and load side of main breaker (if tie breaker is closed, it shall trip before main breaker).
- (3) Coordinate ground protection with Variable Frequency Drive overload protection.

Secondary surge arrestors and protective capacitors, rated for 480-volt system, shall be provided in each main breaker cubicle. Arrestors shall be Type 9L15E M.O.V. series thyrite type, and capacitors shall be General Electric Company CPD series non-PCB filled.

1019-15 LIGHTING EQUIPMENT:

1019-15.1 Switches: Wall switches shall be indicating, toggle, quiet, flush mounting type conforming to Federal Specification W-S-896-D, as follows:

<u>Switch Type</u>	<u>Manufacturer</u>
Single-Pole	Arrow-Hart No. 1991
Double-Pole	Arrow-Hart No. 1992
3-Way	Arrow-Hart No. 1993
4-Way	Arrow-Hart No. 1994
Single-Pole, Key Operated	Arrow-Hart No. 1991-L
Single-Pole, Pilot Indicating	Bryant No. 4901-PLR120
Momentary Contact, 2-circuit, Center Off	Arrow-Hart No. 1895
Weatherproof Cover, Toggle Switch	Crouse-Hinds No. DS181
Explosion Proof, 20A, 120/277 V, 1P, Cast Box	Crouse Hinds EDS Series

1019-15.2 Receptacles: Wall receptacles shall be as follows:

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<u>Receptacle Type</u>	<u>Manufacturer</u>
Duplex, 20A, 125V, 2P, 3W	Arrow-Hart No. 5362
Weatherproof, Corrosion-Resistant, Single, 20A, 125V, 2P, 3W, with Cover	Crouse-Hinds No. WLRS-5-20
Weatherproof, Corrosion-Resistant, Duplex, 20A, 125V, 2P, 3W, with Cover	Crouse-Hinds No. WLRD-5-20
Ground Fault Interrupter, Duplex, 20A, 125V, 2P, 3W	Arrow-Hart No. 1591-F, GF 5342
Stainless Steel Indoor Mtg. Plate for GFI Receptacle	Arrow-Hart No. 97061
Explosion-Proof, 20A, 125V, 2P, 3W	Appleton No. EFS175-2023 or EFSC175- 2023 (with No. ECP-1523 Cap)
Clock Hanger, 15A, 125V, 2P, 3W	Arrow-Hart No. 452
Single, 20A, 250V, 2P, 3W	Arrow-Hart No. 5861
Single, 30A, 125V, 2P, 3W	Arrow-Hart No. 5716 (with No. 5717 Cap)
Clothes Dryer, 30A, 125/250V, 2P, 4W	Arrow-Hart No. 5744
Single, 30A, 250V (3-Phase), 3P, 4W	Arrow-Hart No. 8430N (with No. 8432AN Cap)

1019-15.3 Device Plates:

- (a) **Flush Mounted:** Plates shall be stainless steel.
- (b) **Surface Mounted:** Plates shall be same material as box.

1019-15**1019-15.4 Lamps and Ballasts:**

<u>Item</u>	<u>Type</u>	<u>Manufacturer</u>
Incandescent Lamps	Frosted, Medium Base, 2500-hour life	General Electric Company
Fluorescent Lamps	Medium Bi-Pin & Recessed Double Contact, Rapid Start, Cool White	General Electric Company
Fluorescent Ballasts	Energy Saving, Class P, Rapid Start, High Power Factor, 120V	_____
Mercury Vapor Lamps	Deluxe White	_____
Mercury Vapor Ballasts	Constant Wattage, Auto-Transformer	General Electric Company
High Pressure Sodium Lamps	Clear	_____
High Pressure Sodium Ballasts	Constant Wattage	General Electric Company
Metal Halide Lamps	Clear	_____
Metal Halide Ballast	Constant Voltage, Auto-Transformer	General Electric Company

1019-15.5 Flexible Fixture Hangers: Hangers shall be Crouse-Hinds Company Type ARB in non-hazardous areas, and Type ECHF in hazardous areas.

1019-15.6 Handlamps:

(a) **Explosion-Proof Handlamp:** An Appleton Electric Company No. EHL 100 explosion-proof handlamp shall be furnished with 50' Type SO heavy-duty cord and No. ECP 2023 plug.

(b) **Vaportight Handlamp:** A Daniel Woodhead Company No. 12303R-B163 vaportight handlamp shall be furnished with reflector, 50' cord and grounding plug.

1019-15.7 Lighting Contactor: Contactors shall be Automatic Switch Company No. 1255-166RC, electrically operated, mechanically held, 25A-600V rated (minimum), in NEMA 1 or 4 enclosures.

1019-15.8 Lighting Control Time Switches: Switches shall have astronomic dials and reserve power, and be the following types:

<u>Type</u>	<u>Manufacturer</u>
Momentary Contact Operation	Tork Time Controls No. 1847ZL(120V) and 1848ZL(208/277V)
SPST Maintained Control	Tork Time Controls No. 7100 ZL(120V) and 7102 ZL(277V)
DPST Maintained Control	Tork Time Controls No. 7202ZL(208V)

1019-15.9 Lamp Changing Equipment: Equipment shall be 3 McGill No. 160P 5' poles and 2 No. 161C lamp holders, and shall be able to handle BT-37, E-18, E-23 1/2 and E-28 H.I.D. lamps in open luminaries.

1019-15.10 Emergency Lighting Units: Units shall be Emergency Lighting and Systems, Inc. battery powered units with time delay relay to maintain emergency lighting in H.I.D. source lighted areas for 5 minutes after normal power is restored.

1019-16 MOTOR CONTROL CENTERS: Motor control centers shall be General Electric Company 8000 line, designed for 60 Hz service and the specified short circuit current. Circuit breakers and fuses shall be rated not less than design short circuit rating.

(a) **Construction:** Motor control center shall be a standard metal-enclosed, freestanding, dead-front structure, not more than 90" high and fabricated from 14-gage steel. Enclosures shall be NEMA 1A for interior installations and NEMA 3R for exterior installations. Control centers shall consist of vertical sections of equal height containing individual plug-in compartments. Compartments shall be isolated from each other by separate horizontal steel plates without openings that are part of the compartment. Compartment widths and depths shall be 20".

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Plug-in compartments shall totally isolate enclosed equipment. Unused openings to adjacent vertical wiring space shall be plugged. Openings for wiring shall have insulating grommets.

Vertical sections shall be mounted on steel channel sills continuous on 4 sides or with steel channel sills on 2 sides and end cover plates. Each compartment shall have a hinged door of pan construction on front and a door opening of sufficient size to permit removal of equipment. Interlocks shall be provided to prevent opening compartment door when disconnect device in compartment is in closed position. An interlock bypass device shall be furnished. Means of locking disconnect device in "OFF" position shall be provided. Disconnect device operating mechanism shall not be attached to compartment door.

All sections shall have the same structural features with provisions for addition of similar sections at either end. Each compartment shall meet NEMA standards for the control equipment installed, and units of similar size shall be interchangeable.

Each section shall be provided with a horizontal wiring space which shall line up with a similar space in adjacent sections, with openings between so that wires may be pulled entire length of control centers. Each section shall have a vertical wiring space with separate full height door.

Control centers shall be designed for against-the-wall mounting. Wiring, bus joints and other parts requiring maintenance shall be accessible from the front.

Control centers shall have engraved laminated nameplates screwed to doors of each compartment and wiring diagrams pasted inside each door. Compartments containing motor starters shall have an overload heater selection table pasted inside door. Minimum starter size shall be NEMA 1.

Construction shall be NEMA Class II, Type B or C. Insofar as possible, all devices and components used shall be of one manufacturer. Control centers shall be factory assembled units. Control centers shall be finished with ANSI Z55.1, No. 61 light grey enamel over a rust resistant primer.

Power company metering current and potential transformers shall be installed in service entrance sections.

(b) **Buses:** Buses shall be silver-plated copper. Continuous main horizontal bus shall be furnished. Main buses shall be rated not less than 600 amperes. Main breaker service entrance sections may be cable connected to transfer switch section where required due to space limitations.

Each vertical section shall have a full height bus rated not less than 300 amperes. Vertical buses shall be insulated and isolated with glass polyester or equivalent continuous insulation.

Taped buses will not be acceptable. Unused stab openings shall be plugged. Lower ends of vertical buses shall be insulated.

A 1/4" x 2" ground bus shall be furnished the entire length of control centers. A full capacity neutral bus shall be furnished. All buses except neutral and ground buses shall be completely isolated by steel plates or insulating material.

(c) **Wiring:** Wiring shall be copper. Compartment wiring shall be to compartment mounted, plug-in terminal blocks that allow compartments to be withdrawn without having to remove wires from fixed terminal blocks. Power wiring shall be black; control wiring shall be red; wiring energized from sources other than starter control power transformer shall be yellow.

Control wiring size shall be not less than AWG No. 14.

Control wiring shall be uniquely numbered at each end.

(d) **Signing:** Each control center shall have a sign marked "DANGER - HIGH VOLTAGE". Letters shall be 1" high, 1/4" stroke. Signs shall be laminated plastic, engraved red letters with white background.

Compartments with voltages from sources outside of compartment shall have a vinyl sign approximately 3" x 5" on compartment door marked "CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM A SOURCE OUTSIDE OF THIS UNIT." Letters shall be black on high visibility yellow background.

(e) **Components:**

(1) **Combination Motor Starters:** Motor starters shall be 2- or 3-pole, 60 Hz, 600V magnetically operated. Enclosures shall be not less than NEMA Size 1.

Motor starters shall have 2-N.O. and 2-N.C. auxiliary contacts. Additional auxiliary contacts shall be furnished where specified or as required by control scheme.

Full voltage, non-reversing starters, NEMA size 4 and smaller shall be of plug-in design with stab-on connectors engaging vertical buses. Larger units shall be of fixed design. Reduced-voltage starters shall be auto-transformer type with closed circuit transition. Auto-transformers shall be dry type with 50, 65 and 80% voltage taps. Auto-transformers shall have over-temperature protection. Timing relays shall be adjustable. Relay settings shall be approximately 75% of relay range. Two-speed starters shall be provided for single or 2-winding motors as specified.

Overload relays shall be adjustable, ambient temperature compensated and manually reset by pushbutton in compartment door. Control power transformers shall be sized for additional load where required. Transformer primary and secondaries shall be equipped with time-delay fuses. Disconnect switch and circuit breaker operating mechanisms

shall not be mounted on cubicle doors. Fused switches shall be heavy duty, quick-make, quick-break, 3-pole, 600V with visible break contacts

and current limiting fuses. Fused switches shall be used in combination magnetic motor starters where specified for control of motors rated less than 3 hp at 480 volts or 1-1/2 hp at 208 volts.

Motor circuit protectors shall be provided and shall be molded case with adjustable magnetic trip only. They shall be designed for use with magnetic motor starters. Protectors shall have auxiliary disconnect contacts when used with starters having external control circuits, or a separate switch shall be furnished. Protectors shall be furnished with bolt-on current limiting fuses where required for available fault currents.

(2) **Circuit Breakers:** Circuit breakers shall be molded case, with thermal and magnetic tripping, 480V, 240V or 208V as specified, with RMS interrupting capacity not less than motor control center short circuit current rating. Breakers with 225-amp frames and larger shall have interchangeable trips.

Breakers shall have auxiliary disconnect contacts when used with starters having external control circuits. Breakers for service entrance mains shall have shunt trips and 1-N.O. and 1-N.C. auxiliary contacts. Breakers 800-amp and larger shall have adjustable ground fault trip system.

(3) **Fused Switches:** Switches shall be heavy duty, quick-make, quick-break, 3-pole, 600V, with visible break contacts and shall have current limiting fuses with capacities suitable to supply but protect maximum load circuit.

(4) **Control Stations:** Stations shall be standard size, heavy-duty, oiltight.

(5) **Indicating Lights:** Lights shall be low voltage transformer operated.

(6) **Relays:** General use and latching relays shall be 300V industrial type with 10A convertible contacts. Time delay relays shall be 600V, 20-amp, with knob operated adjustment and linear dials. On-delay, off-delay, double acting and timing ranges shall be as required or as specified.

(7) **Running Time Meters:** Meters shall be General Electric Company Type 236, 3 1/2" square case, non-reset, 99,999.9-hr range.

(8) **Timers:** Timers shall be Eagle Signal Division, E.W. Bliss Company flush-mounted, plug-in, Bulletin 125 Cycle-Flex reset timers.

(9) **Voltmeters, Ammeters and Wattmeters:** Meters shall be General Electric Company Type AB-40, 4 1/4" square, 250° scale, $\pm 1\%$ accuracy switchboard instruments.

(10) **Instrument Transformers:** Transformers shall be indoor, 600V, butyl-rubber molded metering class designed in accordance with ANSI and NEMA standards.

(11) **Current Transducers:** Transducers shall be Rochester Instrument Systems Series CCC-1B, 0-5 amp A.C. input, 0-20 milliamp D.C. output, $\pm 0.5\%$ accuracy.

(12) **Voltage Transducers:** Transducers shall be Rochester Instrument Systems Series VCC-1B, 0-150 amp A.C. input, 0-20 milliamp D.C. output, $\pm 0.5\%$ accuracy.

(13) **Watts Transducers:** Transducers shall be Rochester Instrument Systems Series PCE, 3-phase, 120V and 5 amp A.C. input, 0-20 milliamp output, $\pm 0.5\%$ accuracy.

(14) **Automatic Transfer Switch:** Switches shall be Automatic Switch Company Bulletin 940, designed for an emergency and normal source of 30-Hz, 480V, 240V or 208V as specified. Emergency source may be a local engine-generator or commercial source. Switch shall be designed for mounting in a 20" wide motor control center section. Switch shall transfer load to emergency source when any phase of normal source drops below 90% of normal voltage, but shall be adjustable for other settings.

Switch shall be constructed to carry its full rated current on a continuous 24-hour basis and shall not show excessive heating or be subject to de-rating. Switches shall be capable of withstanding inrush current values to 20 times its full load current rating without mechanical distortion of main contact poles or supports, and withstanding all available system fault clearing time of system over-current device.

Switch shall be of double throw construction, and time of load transfer from normal to emergency to normal shall not exceed 1/6 of a second. The following accessories capabilities shall be furnished:

- (a) Adjustable time delay on engine-generator starting or transfer to alternate source of 0-2 minutes.
- (b) Adjustable time delay on retransfer to normal of 0-2 minutes unloaded running time of generator.
- (c) Auxiliary contacts to close when normal source fails (for engine start or other controls).
- (d) Close differential relay protection on normal.
- (e) Auxiliary contacts to close on transfer to emergency source (Combustion, air damper or other controls).
- (f) Two auxiliary contacts to open and 2 to close on transfer to emergency source and reverse on transfer to normal source.
- (g) Auxiliary contacts to open 0-30 seconds (adjustable) before transfer to either normal or emergency source and to close after transfer. These contacts are to cause pumps to stop before transfer to either source and allow restart after transfer. Ten contacts are required.

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(h) Phase reversal protection to prevent transfer from normal to emergency or emergency to normal if source phases are reversed.

(15) **Surge Protection:** A lightning arrestor and surge capacitor conforming to Subsection 1019-8.8 shall be provided on each service.

1019-17 PUMP CONTROL AND SERVICE ENTRANCE PANELS: Pump control panels shall be furnished by pump supplier and shall be completely wired, including all interlocking between motor control, accessory devices, and level sensor systems. The supplier shall submit complete wiring diagrams, ladder diagrams, dead front panel layout, sub-dead front panel layout, etc. for approval.

Programmable controllers shall be manufactured by Consolidated Electric Company. Each panel shall have a UL label attached. Panel manufacturer shall be Consolidated Electric Company.

(a) **General:** Each service entrance panel shall have a main breaker and a generator receptacle breaker mechanically interlocked and service entrance rated. Breakers and wiring shall be behind an interior dead front door or panel. When interior or exterior door is opened, breaker interlock shall remain in effect between main and generator source.

Hand-Off-Automatic selector switches shall be supplied and installed for each pump motor. Time delay relays and programmable controller timed outputs are required for each pump motor. Time delays shall delay pump motors from starting upon resumption of service power such that only one motor can be started at a time. Pilot lights shall be supplied as specified.

A meter for recording total elapsed running time for each motor shall be supplied. Meter shall be 6-digit, non-resettable, recording in hours and tenths. Where specified, install motor starters, main breakers, emergency breakers, generator receptacles, surge protection equipment, phase monitors, pressure transducers, lightning arrestors, etc.

Penetrations shall be cut by the panel manufacturer in accordance with the approved penetration layout. Penetrations shall be sealed with Myers hubs by the panel manufacturer and shall be furnished with galvanized conduit plugs, unless equipment or devices are installed on the Myers hubs in the shop.

Penetration on top of panel for mounting alarm light shall be flared to facilitate seal of Myers hub.

(b) **Service Entrance and Pump Control Panels:**

(1) **General:** Panels shall not have exposed bolts, nuts or screws, and shall be compartmentalized, NEMA 4x stainless steel. Exterior of panel shall not be painted; interior shall be painted white. Cabinet sizes shall be approved prior to fabrication.

(2) **Service Entrance Panel:** Panel shall house main circuit breaker and generator receptacle circuit breaker from being closed concurrently. Panels shall have ratings approved by NEC and local ordinances.

Generator receptacles shall be attached to panel and connected to generator receptacle circuit breaker. Generator receptacles shall be such that plug is a female fitting and panel mounted device is a male fitting. Main breaker, generator breaker and wiring shall be located behind interior dead front door or panel. Interlocks and circuit breaker operation shall be possible without opening door or removing panel.

(3) **Pump Control Panel:** Cabinets shall be Hoffman Bulletin A4. Permanently attached plan pockets shall be provided on exterior door. Also, permanently attached door holders shall be provided at top of inner and outer doors. When panel is on an elevated platform, double inner and outer doors shall be provided.

Exterior door fasteners shall be stainless steel handles with 3-point roller bearing latches. Hinges, screws, nuts and bolts shall be stainless steel. Provision shall be made for locking panel with a No. 5 master lock. Enclosure shall be compartmentalized such that programmable controller, telemetry contact, service entrance and power sections are isolated from each other. Service entrance section shall be isolated by a barrier and a removable dead front cover that is separate from inner dead front door. Compartments containing programmable controller, telemetry contact and power sections shall be separated by barriers behind inner dead front door. Programmable controller and telemetry contact section shall be located on side of pump control panel that is to be adjacent to future telemetry interface panel. Doors shall be hinged on same side and shall open to greater than 90°. Inner door fasteners shall be chrome plated knurled knobs with 3/16" latches.

Thermostatically controlled heating and cooling systems shall be provided as required to provide proper operation of panel.

Control transformers shall be Square D Class 9070.

Wet well level gage shall be pneumatic type connected to air system to indicate wet well levels in feet. Gage shall be separate from programmable controller digital read-out. A digital read-out indicator measuring wet well levels in feet and tenths shall be provided and connected in series with pressure transducer 4-20 MA signal.

Panel wiring shall be No. 14 AWG stranded minimum. Wiring within panel shall be grouped together in power, control, and instrumentation classes with harnesses where wiring ducts cannot be used. Use General Electric Company NORYL thermoplastic wiring ducts secured to structure where possible. Shield instrumentation cables as required for proper operation.

(c) **Operating Controls and Instruments:** Operating controls and instruments shall be mounted on control compartment interior door. Controls and instruments shall be labeled to indicate function. Labels shall be white laminated plastic with black etched letters secured with stainless steel hardware.

Pump mode selector switches shall be Hand-Off-Auto type to permit complete override of automatic controls and manual shutdown of pump motors. Manual mode operation shall not bypass pump motor failure circuits. Switches shall be oil-tight, as manufactured by Allen-Bradley. Separate indicator lamps shall be provided for pump run, failure, etc.

Indicator lamps shall be mounted in oil-tight modules, as manufactured by Allen-Bradley. Lamp modules shall be equipped to operate at 120 volts input. Lamps shall be replaceable from front of control compartment door without removing lamp module. Lamps shall be provided with "push to test" feature.

A 6-digit, non-reset elapsed time meter shall be connected to each motor starter to indicate total running time to each pump in hours and tenths. Meters shall be Bulletin 705, HK Series as manufactured by Eagle Signal/Stacon.

Control relays shall be plug-in Struthers-Dunn Type 219BBXPL.

Time delay relays shall be solid state Struthers-Dunn Type 236ABXPL.

An open frame, across-the-line, NEMA rated, magnetic Square D Company motor-starter, Class 8536, shall be furnished for each pump motor. Motor starters shall be equipped to provide overload protection on all 3 phases. Motor starter contacts shall be replaceable without removing motor starter. Overload reset push buttons shall be located on exterior of control compartment dead front door. Overload relays shall have N.O. and N.C. dry contacts, shall be ambient temperature compensated and shall be sized according to motor nameplate FLA.

Where specified, surge protection equipment and lightning arrestors shall be supplied in the control panel. Lighting arrestor and surge protector shall be as specified in Subsection 1019-8.8.

Devices installed in the NEMA 4X enclosure shall be maintained within their rated temperature limits based on internal enclosure temperature to be experienced with panel installed and operating in a 105° F ambient outdoor location with panel in direct sunlight. The manufacturer shall perform a temperature analysis to determine maximum internal cabinet temperature to be experienced under above conditions. This analysis shall take into account external environmental temperature factors as well as heat generated by internal devices. The manufacturer shall provide forced air ventilation if necessary to keep panel components within their rated temperature limits. If forced air cooling is required, duplex fans with alternation and failure protection shall be mounted inside control panel. Openings shall be vandal resistant, and insect and varmint proof, and shall prevent water intrusion from a hose spray or wind driven rain. Breather/drains shall be Crouse-Hinds Type ECD.

Reduced voltage motor starters shall be provided where required by power company.

Control panel shall have a Diversified solid state 3-phase power monitor protection against loss of phase, low voltage on any phase, or phase reversal from ABC sequence.

Monitor shall have a 2-second trip delay, and a 1-minute adjustable restart delay. An adjustable low voltage adjustment shall be provided which will automatically reset when trouble clears and shall have N.O. and N.C. dry alarm contacts.

Main generator and branch feeder circuit breakers shall be Square D Company molded case type with thermal and magnetic tripping. Minimum fault current ratings shall be 22,000 amps symmetrical for 240-volt services, and 14,000 amps symmetrical for 480-volt services. Interrupting fault current ratings shall be increased where required by service entrance applications.

Square D Company motor circuit breaker protectors shall be furnished for each pump motor starter. Breakers shall be sized for motor to be served and sealed by manufacturer after calibration to prevent tampering. Motor circuit protectors shall have fault current ratings as specified for main and branch feeder breakers.

Control transformer branch circuit breakers shall be Square D type QOB.

Generator receptacle shall be Crouse-Hinds Company AREA Series with male inserts. On 480-volt service locations, inserts shall be rotated 22.5°.

Motor breakers and branch circuit breakers mounted in pump control panel shall be compartmentalized across top to separate service, motor feeds, and control transformer branch circuits between each and other sections of control panel. Equipment and devices shall be mounted to removable back panels tapped to accept mounting screws with lock washers. Self-tapping screws shall not be used. Mounting brackets shall be used to locate equipment at separate dead front cover and equipment shall be sealed for dead front requirements.

Motor starters, overload relays, control relays, air compressor, temperature controls, etc. shall be compartmentalized from other sections of pump control panel. Equipment and devices shall be mounted to removable back panel tapped to accept mounting screws with lock washers. Self-tapping screws shall not be used.

Duplex receptacles shall be 20A, 125V, 2P, 3W; Arrow-Hart, Catalog No. 5362. Ground fault interrupter breakers shall be square D type QOB.

Pump control panel shall have a thermostatically controlled heater strip to maintain a minimum cabinet temperature of 36° F.

Motor winding temperature and leakage sensor shall be Flygt mini CAS. Leakage sensor shall be Flygt FLS.

(d) **Float Arms and Controls:** Provide 2 Healy Ruff PVC float switches. Mercury switch contact shall not be affected by rotation of float about its longitudinal axis and shall be designed for operation with the system specified. Float switch shall be supplied with neoprene jacketed control cable of sufficient length to reach control panel without splicing. Verify locations of control panel for exact lengths of cable and operation.

Float switches shall be protected by intrinsically safe relays with lighted indicators and test pushbuttons mounted on dead-front. Unit shall be Consolidated Electric Company Model No. CBIT. System shall auto reset after power outages or spurious signals. System shall be suitable of operation in wet wells up to 30-feet deep with control panel remotely located. An input suppression network shall be provided as required for proper operation.

(e) **Level Sensing and Transmitting:** Level sensing system shall operate on captive air principle and shall consist of a compressor, 3-way solenoid valve, pressure transmitter, compression bell, air lines and manual valves. Hardware for mounting compression bell in wet well shall be supplied by pumping equipment supplier. Electronic instruments shall be rated to operate properly between 32° F and 140° F and accept 120 VAC 60Hz.

One pressure transducer, Consolidated Electric Company Bulletin A 300 Model 221GCD, shall be provided, having the following features:

1. Continuous adjustable span
2. Zero and dampening adjustments
3. Solid state circuitry with 4-20 MA output
4. Accuracy shall be $\pm 0.5\%$
5. Electronic circuits shall automatically reset after restoration of power outages or spurious signals.
6. An input suppression network shall be provided as required for proper system operation.

Connection from pump control panel to compression bell shall be rubber air hose installed from control panel in 1-1/4" PVC pipe, and shall be continuous to wet well without splicing. Sensing element and parts outside pump control panel shall be PVC, nylon, rubber or stainless steel. This unit shall not be harmed by normal domestic sewerage or require cleaning or adjusting should wet well level flood or fall below bottom of wet well air bell. A check valve shall be provided if required.

Compressor shall be Gast Model 1HAB-10-M-1004. System shall develop a minimum of 50 psig on purge and be suitable for operating in wet wells up to 30-feet deep.

Solenoid valves shall be ASCO model 8360-A77.

Automatic timing and manual purge button shall activate 3-way solenoid valve, then compressor and steady state hold of electronics during and after purge blow-down, and shall be time coordinated to prevent damage to electronic and air control systems.

(f) **Programmable Controller:** Programmable controller (PC) shall be provided by panel manufacturer and shall be a Consolidated Electric Company model D620 controller. PC shall be a stand-alone computer capable of gathering data and controlling multiple functions in unattended installations. PC shall consist of inputs, outputs, a processor controller with memory, and a power supply. Wiring terminals shall terminate field wiring to I/O points. Devices shall be removable without disturbing wiring by utilizing pull-apart terminal blocks. PC shall be supplied with all necessary accessories and expansion equipment required to meet specified input and output capabilities and to perform required functions.

Electronic circuitry shall automatically reset after power outages or spurious noises and resume normal operation with no reprogramming necessary. An input suppression network shall be provided as required for proper system operation.

Processor shall examine status of inputs and outputs at least twice every second and store the data. The program shall be stored in memory also. PC processor execution speed shall be 2MHZ minimum.

PC software developed for the project shall be turned over to and shall become the property of the Owner. Software shall be in such a form that it can be downloaded to PC via an IBM compatible personal computer.

PC shall have diagnostic indicators to show the following conditions by LED or alphanumeric display:

- (a) CPU Fault
- (b) Battery Low
- (c) Forced I/O

PC shall be capable of operating in an ambient temperature of 32° F to 140° F with a humidity of 5-95%, non-condensing, and shall meet NEMA Isolation Standards ICS 2-230 for noise immunity and be UL Listed.

PC manufacturer shall supply a list of recommended spare parts for PC with manufacturer's current price for each item.

(1) **Configuration:** PC shall be a complete plug-in modular intelligent unit, equipped with built-in peripherals that enable it to gather data, compute results and take action based on stored control strategies. PC shall be compatible with harsh physical and electrical environments. Digital inputs and outputs shall have 2,500V

optical isolators, and analog inputs and outputs shall have over-voltage protection. Input circuits shall have filtering to guard against high voltage transients from externally connected devices. Surge protection on input and output circuits shall meet NEMA isolation standard ICS 2-230 and IEEE standards.

(2) **Watchdog:** To account for transients and other burst errors or software errors, a hardware watchdog timer that constantly tests for errant operation shall be provided. When an error occurs, watchdog timer shall restart computer and trip a PC fault relay to initiate alarms.

(3) **Program Storage:** Program storage for field selectable items shall employ low power, high noise immunity CMOS RAM or EEPROM. Continuous memory error detection and correction shall be provided that is capable of detecting and correcting any single byte error.

(4) **Communications:** PC shall be provided with an RS232 communications port and shall be capable of sending and receiving serial data through port to allow local communications to remote data acquisition and control systems via telephone modem or dedicated channels. It shall be possible to change levels or similar type settings as well as interrupt station operation remotely with PC's communication provisions.

(5) **Display:** A numeric or alphanumeric display shall be provided on PC front panel that shall be used with keyboard to present, in engineering units, floating point representations of measured values, timers, memory, availability, etc. It shall be used to display error messages and to examine program while running.

(6) **Memory Tests:** Before PC begins controlling a process, upon power application, it shall run through a series of memory tests that verify PROM, RAM and EEPROM integrity. An error shall trip fault relay and issue an error message. It shall also test RAM and EEPROM continuously and correct soft errors.

(7) **Registers:** Floating point representations of analog values shall be held in registers as required. Registers shall be used for analog inputs, and for intermediate results or setpoints. Registers may be read or written into at any time, but associated with analog inputs shall be changed when next analog sample is taken. Register contents shall be nonvolatile in that they will be retained through a power outage of up to 10 years.

(8) **Timers, Counters and Sequences:** PC shall have the minimum capability of utilizing 162 internal timers, counters and sequences. Timers shall be available in on-delay and off-delay with 0.1 second time bases and timer range from 0.1 to 999.9 seconds. Counters shall be available in count up and count down and have a capacity of 9999 counts. Sequences shall have a minimum capacity of 8 bits by 100 steps and be cascable, time- or event-driven. Additional timers, counters and sequences shall be provided if required to perform control functions.

(9) **Inputs and Outputs:**

(a) **Analog Inputs:** At least 3 analog inputs shall be provided on PC to gather information that has a value as opposed to status inputs that are either on or off. At least 1 input shall be configurable as voltage (0-5 VDC) or current (4-20MA) compatible. The other 2 inputs may be current compatible (4-20 MA only). Each input shall employ over-voltage protection.

(b) **Analog Outputs:** Analog outputs shall be used to exert proportional control over external devices. They shall use D/A converters that update analog output channels several times per second. Analog output channels shall be 4 to 20 MA current loop compatible. They shall employ over-voltage protection and diode reverse current protection. At least 1 analog output shall be available on each PC.

(c) **Status Inputs:** Status inputs shall be implemented in each unit to sample on/off status of external contacts or logic states. At least 24 status inputs shall be provided with additional inputs provided if required using expansion units. There shall be a 2,500 optical isolator on each status input.

(d) **Control Outputs:** At least 12 control outputs shall be provided with additional outputs provided if required using expansion units. Each output shall be rated for 5A, 120V, AC minimum and shall be provided with surge suppressors. Units may employ slave relays to achieve rating.

(10) **Memory:** PC shall be equipped with at least 16 Kbytes of EPROM (Erasable, Programmable Read Only Memory) and 8 Kbytes of RAM (Random Access Memory) and/or EEPROM (Electrically Erasable, Programmable, Read Only Memory). Additional memory shall be provided as necessary for proper operation. EPROM shall be used to hold PC operation system. RAM or EEPROM shall be utilized to hold field selectable items such as set points and to handle operational computing tasks. A lithium battery shall be provided to maintain any RAM utilized to hold field selectable items and other data required to be nonvolatile and to maintain PC internal clock. Battery or EEPROM shall maintain memory contents required to be nonvolatile during power outages of up to 10 years. Battery alarm output contact shall be provided for low battery condition. Low battery condition shall cause a local alarm and telemetry alarm. RAM and EEPROM shall be

write protected except when unit is in a program mode. EPROM memory contents shall be tested every time power is applied or watchdog timer times out. If an error is detected, process shall be stopped and fault relay tripped. RAM and EEPROM memory shall be checked upon power application and watchdog timer timeout, and during program execution in an interleaved fashion. If an error is detected, it shall be corrected if possible. If an error cannot be corrected, process will be stopped and fault relay switched.

(11) **Fault Relay:** Fault relay shall go to fault state in any of the following situations and shall cause a local alarm and a telemetry alarm:

- (a) Power fail
- (b) Watchdog time timeout
- (c) Memory failure

(12) **Power Interface:** PC system shall accept power of 85-132V, 47-65HZ and continue with normal operation. Power input to PC shall be fuse protected.

PC shall be flushed mounted to an opening in dead-front door such that displays, mini annunciator and keyboard are accessible without opening inner dead-front door.

(13) **Set-Point Mode:** It shall be possible to access, view and change any setpoint register in PC after execution of password and entering command mode. Such setpoint changes shall not interrupt normal operation and execution of program in PC. Password shall be field changeable.

SECTION 1020

SIGNS AND PAVEMENT MARKINGS

1020-1 SIGNS: Signs and pavement markings shall conform to the MUTCD and the following requirements.

1020-1.1 Temporary Signs and Barricades:

(a) **Posts:** Sign supports shall be approved flanged channel steel posts, 4" round or 4" x 4" square timber posts, or approved metal or timber easels.

(b) **Sign Blanks:** Sign blanks shall be 0.080" thick aluminum sheeting or 5/8" thick exterior plywood. Cut edges of plywood shall be sealed.

(c) **Barricades:** Barricade rails shall be constructed of 5/8" thick exterior plywood or clear, sound 1" nominal thickness lumber. All other barricade components shall be constructed of clear, sound lumber; however, Type II barricades may be on metal supports.

(d) **Drums and Flexible Delineators:** Drums shall be plastic drums listed in the QPL. Flexible post delineators shall be products listed in the QPL.

(e) **Reflective Sheeting:** Reflective sheeting shall conform to the following ASTM D 4956 requirements.

Signs and Barricades	Type II or III
Drums	Type III
Cones and Delineators	Type IV

(f) **Barricade Warning Lights:** Warning lights shall be approved products on the QPL.

1020-1.2 Permanent Roadside Signs:

(a) **Posts:** Posts shall be flanged channel galvanized steel posts weighing at least 2.4 lb/LF.

Posts shall be fabricated from steel conforming to ASTM A 499, Grade 60 or ASTM A 576, Grade 1080. Holes 3/8" in diameter shall be drilled or punched through middle of post on 1" centers for at least 36" from top of post. Posts shall be galvanized after fabrication in accordance with ASTM A 123.

(b) **Sign Blanks:** Sign panels shall be fabricated from 0.080" thick aluminum sheeting conforming to ASTM B 209, Alloy 6061-T6 or 5052-H38.

(c) **Reflective Sheeting:** Reflective sheeting shall conform to ASTM D 4956, Type II or III.

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(d) **Nonreflective Sheeting:** Nonreflective sheeting shall consist of an extensible, pigmented, weather-resistant plastic film. Face side of film shall be supported and protected by a paper liner which is readily removable after application without soaking in water or other solvents. Colors shall be matched visually and be within limits shown in Table 10 of ASTM D 4956.

(e) **Fasteners:** Fasteners for fabricating sign faces shall have brasier heads and shall be manufactured from aluminum conforming to ASTM B 316, Alloy 2024-T4. Collars shall be of the type and alloy recommended by the manufacturer.

Fasteners for attaching demountable legend to sign faces shall be 1/8" diameter blind rivets manufactured from aluminum conforming to ASTM B 316, Alloy 1100-H14.

Fasteners for attaching signs to posts shall be 1/4" diameter aluminum rivets conforming to ASTM B 316.

1020-2 STRIPING:

1020-2.1 Temporary Striping:

(a) **Striping Tape:** Tape shall conform to ASTM D 4592, Type I (removable) or Type II (non-removable) and shall be a product listed in the QPL.

(b) **Painted Stripe:** Paint shall conform to Subsection 1020-2.2.3 and glass beads for drop-on application shall conform to Subsection 1020-2.2.4.

1020-2.2 Permanent Striping:

1020-2.2.1 Thermoplastic Striping:

(a) **General:** Material shall be manufactured to be applied by spray or extrusion to pavement in molten form, with internal and surface application of glass spheres, and upon cooling to normal pavement temperature, shall produce an adherent, reflectorized marking.

Materials shall be products listed in the QPL and shall conform to AASHTO M 249.

1020-2.2.2 Preformed Plastic Markings:

(a) **General:** Material shall consist of white or yellow pigmented preformed plastic with glass beads uniformly distributed throughout the cross-sectional area and be capable of being affixed to pavement by either a pressure-sensitive pre-coated adhesive or a liquid contact cement. Solvents and adhesives shall be in accordance with manufacturer's instructions. Marking shall have a shelf life of at least 1 year; contact elements, where used, shall have shelf life of at least 6 months. Material shall mold itself to pavement contours, breaks and faults by action of traffic at normal pavement temperatures.

Marking film shall be capable of use for patching of the same type film.

Markings shall be products listed in the QPL.

(b) **Composition:** Retroreflective pliant polymer film shall consist of a mixture of polymeric materials and pigments with 1.5 to 1.6 refractive index glass beads uniformly distributed throughout its cross-sectional area, and with a reflective layer of beads bonded to top surface. Composition shall be as follows:

<u>Material</u>	<u>Min. % by Weight</u>
Resins and Plasticizers	20
Pigments	30
Graded Glass Beads	33

The remaining percentage shall be comprised of the above materials in various proportions.

(c) **Physical Requirements:**

(1) **Bend Test:** Plastic shall be of such structure that at a temperature of 80°F, a 3" x 6" piece (with backing) placed on a 1" diameter mandrel may be bent over mandrel until end faces are parallel and apart. There shall be no fracture lines apparent in uppermost surface.

(2) **Adhesive Backing Release Material:** Cut a 1/2" x 6" specimen. Remove release material for 1" of length and attach nonadhesive side to a vertical surface with a clamp where release material was removed. Attach a clamp, which has a supported 1-pound weight attached to it, to end of partly removed release material. No release material shall remain on specimen after weight is released.

(3) **Tensile Strength:** Film shall have a minimum tensile strength of 2.5 lb/inch of width when tested by ASTM D 3759 except that a sample shall be tested at 75±5°F using a jaw speed of 10" to 12" per minute.

(4) **Pigmentation:** Pigments shall be selected and blended to provide a white or yellow marking film which conforms to standard highway colors. White film shall have a minimum Whiteness Index of 40 when tested by with ASTM E 313.

(5) **Glass Beads:** Glass beads shall be colorless and have a Refractive Index of 1.5 to 1.6 when tested using liquid immersion method at 77°F. Size and quality of beads shall be such that performance requirements for retroreflective pliant polymer film will be met.

(6) **Friction Resistance:** Surface of retroreflective pliant polymer shall provide a minimum Frictional Resistance Value of 5 British Polish Number (BPN) when tested by ASTM E 303.

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(7) **Abrasion Resistance:** Plastic marking shall have a maximum weight loss of 0.25 gram in 500 revolutions when abraded according to Federal Test Method Standard No. 141A (Method 6192), using CS-0 Calabrade wheels with a 500-gram load on each wheel.

(8) **Retroreflective Requirements:** Material shall have minimum brightness values shown below expressed as millicandelas per square meter per lux. Measurements shall be conducted in accordance with ASTM D 4061.

Observation	Entrance	Specific Luminance	
<u>Angle</u>	<u>Angle</u>	<u>White</u>	<u>Yellow</u>
0.2°	86°	500	400

(9) **Thickness:** Retroreflective pliant polymer film without adhesive shall have a minimum thickness of 60 mils.

(10) **Adhesive Shear Strength:** Specimens shall be tested by ASTM D 638 modified to test adhesive shear strength. Cut 1" x 6" plastic specimens and apply to adhesive face a 1" x 3" piece of carborundum extra coarse emery cloth, or its equivalent, so that there is 1" square overlap between specimen and carborundum. Apply 50 psi pressure on overlaid area for 30 seconds. Place each end of test piece in a tensile test machine. Test specimen for adhesive shear strength by applying a load at rate of 0.25" per minute. Average load test shall be conducted at 75±5°F.

(11) **Adhesive Stability Test:** Precoated adhesive backing shall be pressure sensitive and shall remain stable with a controlled degree of flexibility and flow. Specimen shall be tested by ASTM D 816, Method B modified to hold a static load of 4 pounds for 30 minutes at 75±5°F.

Slippage between plastic panel and emery cloth shall not exceed 1".

(d) **Performance:** Retroreflective pliant polymer, when applied according to manufacturer's recommendations, shall provide a neat, durable marking that will not flow or distort due to temperature. Pliant polymer shall provide a cushioned resilient substrate that reduces bead crushing and loss. Film shall be weather-resistant, and through normal traffic wear shall show no fading, fading, lifting or shrinkage throughout useful life of marking. It shall show no tearing, roll back or other signs of poor adhesion.

1020-2.2.3 Traffic Paint: Material shall be alkyd or water-borne traffic paint. Each container shall bear a label with name and address of manufacturer, trade name or trade mark, type of paint, number of gallons, batch number and date of manufacture.

Paints shall be products listed in the QPL, shall show no excessive settling, caking or increase in viscosity during 6 months of storage, and shall be readily stirred to a suitable consistency for spray application.

(a) **Alkyd Traffic Paint:** Material shall be a rapid-setting compound suitable for use with hot application equipment. The material shall meet the following requirements:

PROPERTY	TEST METHOD	REQUIREMENTS	
		MIN.	MAX.
Weight, lb/gal	ASTM D 1475	12.0	---
Viscosity @ 77°F, Krebs Units	ASTM D 562	85	115
Drying Time, s	ASTM D 711	---	180
Directional Reflectance, %	ASTM E 97	80	---
White		50	---
Yellow			
Bleeding	Fed. Spec. TT-P-115	Pass	
Total Solids, % by weight	ASTM D 1644, Method A	70	---
Film Shrinkage ¹		Pass	
Hiding Power ²		Pass	
Pigment, %	ASTM D 2371	50	---
Nonvolatiles in Vehicle, % by wt	ASTM D 215	35	---
Flexibility		Pass	
Pigment Composition ³	Fed. Spec. TT-P-1952	Pass	

¹ Film Shrinkage: Cast a wet film 30 mils thick over a glass plate. Allow sample to cure at room condition for 4 to 5 hours. Cured film shall have a minimum thickness of 12 mils.

² Hiding Power: Paint shall have a wet hiding power of at least 350 square feet per gallon. Compound shall have sufficient hiding power to cover any pavement when applied at a wet film thickness of 15 mils.

³ Pigment Composition: White paint shall contain at least 1.5 pounds of TiO₂ pigment per gallon with at least 92% TiO₂ content. The TiO₂ shall conform to ASTM D 476. Yellow paint shall contain at least 1.3 pounds of medium chrome yellow pigment per gallon (ASTM D 211, Type III).

(b) **Water Borne Traffic Paint:** Material shall be a rapid-setting waterborne compound suitable for use with hot application equipment. Material shall meet the following requirements:

PROPERTY	TEST METHOD	REQUIREMENTS	
		MIN.	MAX.
Weight, lb/gal	ASTM D 1475	12.0	---
Viscosity @ 77°F, Krebs Units	ASTM D 562	85	115
Drying Time, s	ASTM D 711	---	180
Directional Reflectance, %	ASTM E 97	80	---
White		50	---
Yellow			
Bleeding	Fed. Spec. TT-P-115	70	---
Total Solids, % by weight	ASTM D 1644, Method A	Pass	
Film Shrinkage ¹		Pass	
Hiding Power ²		50	---
Pigment, %	ASTM D 2371	35	---
Nonvolatiles in Vehicle, % by wt	ASTM D 215	Pass	
Flexibility Pigment Composition ³	Fed. Spec. TT-P-1952	Pass	

¹ Paint applied at 15 mils wet on road surface with paint heated to 120-150°F shall not show tracking when vehicle crosses at 3 minutes.

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² Paint shall show no excessive setting, caking or increase in viscosity during 12-month storage and shall be readily stirred to a consistency for use in striping equipment.

³ Yellow shall match Federal Test Standard No. 595, Color 13538. White shall be a clean, bright, untinted binder.

⁴ White paint shall contain at least 1.0 lb of TiO₂ per gallon conforming to ASTM D 476.

1020-2.2.4 Glass Beads For Drop-On Application: Glass beads shall be colorless, clean and transparent, and free from milkiness or excessive air bubbles. The contractor may furnish moisture-proof beads.

(a) **Shape:** At least 70% of beads on each screen shall be true spheres as determined by microscopic examination.

(b) **Refractive Index:** Glass beads shall have a Refractive Index of 1.5 to 1.6 when tested by liquid immersion method at 77°F. Size and quality of beads shall be such that performance requirements for retroreflective pliant polymer film will be met.

(c) **Gradation:** Beads shall conform to the following gradation when tested by DOTD TR 634:

<u>U.S. Sieve</u>	<u>% Retained</u>
No. 20	0
No. 30	10-20
No. 50	30-75
No. 80	9-32 ¹

¹ No more than 15% shall pass No. 80 sieve.

(d) **Acid Resistance:** Approximately 100 beads shall be placed on a microscope slide and immersed in a 3N-H₂SO₄ solution. After 10 minutes immersion, not more than 20 % of beads by count shall show a hazed surface, and there shall be no popping or bursting of beads.

(e) **Sodium Sulfide Resistance:** Place approximately 1 gram of beads in glass container with stopper and cover with a solution of 50% Na₂S, 48% distilled water, and 2% Aerosol OL or similar wetting agent. Shake container frequently and examine beads after 1 hour. Beads shall show no darkening.

1020-3 RAISED PAVEMENT MARKERS:

(a) **Markers:** Markers shall be reflectorized markers conforming to ASTM D 4280 and be products listed in the QPL.

(b) **Adhesives:**

(1) **Epoxy Adhesive:** Epoxy adhesive shall be 2-component epoxy resin system, shall be a product (Type V) listed in the QPL, and shall conform to the following requirements:

<u>PROPERTY</u>	<u>METHOD</u>	<u>STANDARD</u>		<u>RAPID</u>	
		<u>MIN.</u>	<u>MAX.</u>	<u>MIN.</u>	<u>MIN.</u>
Consistency	DOTD TR 702				
Component A (Resin) TD		1000	3500	1000	3500
Spindle at 5 rpm, Poises					3500
Component B (Hardener) TD		1000	3500	1000	
Spindle at 5 rpm, Poises					---
Shear Ratio (each component)		2.0	---	2.0	10
Gel Time, Minutes ¹	DOTD TR 703	6	10	6	40
Tensile Bond Strength to reach 170 psi, Minutes	DOTD TR 706	---	210	---	---
Diagonal Shear Bond Strength	DOTD TR 707				---
24 hour, psi		2000	---	1000	
24 hours, plus 7 day water soak, psi		1500	---	800	

¹ Gel time for mixtures that are mixed and dispensed by hand shall be 7 to 13 minutes.

(2) **Bituminous Adhesive:** Adhesive shall be asphalt material with a homogeneously mixed mineral filler suitable for bonding markers to pavements when road surface and marker temperatures are 40°F to 160°F. Composition of adhesive shall be such that its properties will not deteriorate when heated to temperatures up to 425°F. Adhesive shall be a product listed in the QPL and shall conform to the following requirements.

(a) **Adhesive Properties:**

<u>Property</u>	<u>Test Method</u>	<u>Requirements</u>	
		<u>Min.</u>	<u>Max.</u>
Softening Point, °F	ASTM D 36	200	---
Penetration, 77°F, 100 g, 5 s	ASTM D 5	10	20
Flow, inch	AASHTO T 187 ¹	---	0.2
Heat Stability Flow, inch	AASHTO T 187 ²	---	0.2
Viscosity, 400°F, poises	ASTM D 2669 ³	---	75
Flash Point, COC, °F	ASTM D 92	550	---

¹ Determined according to Section 6 of ASTM D 3407 except that oven temperature shall be 158±2°F and sample preparation shall be according to Section 7.1 of ASTM D 5.

² Determined according to flow except that 1000 grams of adhesive shall be placed in a covered quart can, heated to 425°F and maintained at this temperature for 4 hours prior to preparing sample panel.

³ Determined according to ASTM D 2669 using a spindle speed of 10 rpm. Adhesive shall be heated to approximately 410°F and allowed to cool. Viscosity shall be determined at 400±1°F.

(b) **Asphalt Properties⁴:**

<u>Property</u>	<u>Test Method</u>	<u>Requirements</u>	
Penetration, 77°F, 100 g, 5 s	ASTM D 5	25	---
Viscosity, 275°F, poises	ASTM D 2171	12	---
Viscosity Ratio, 275°F, Aged/Original		---	2.2

⁴ Asphalt properties determined on filler-free material derived from extraction and Abson recovery process.

(c) **Filler Properties⁵:**

<u>Property</u>	<u>Test Method</u>	<u>Requirements</u>	
		<u>Min.</u>	<u>Max.</u>
Filler Content, % by wt	AASHTO T 44	50	75
Filler Fineness, % passing by wt	ASTM C 430 ⁶		
Sieve No. 300		100	---
Sieve No. 200		95	---
Sieve No. 325		75	---

⁵ Filler properties determined on material derived from extraction.

⁶ This method shall be modified by use of a water-soluble, nonionic wetting agent, to aid wetting action. Concentration of surfactant solution shall be approximately 1% by weight. Dry sample shall be wetted in surfactant solution and allowed to soak for 30 minutes. Filler shall be transferred into sieve cup and water-spray applied for 2 minutes. Surfactant solution may be added as needed and physical means used to disperse clumped particles. Sample shall then be dried and handled as directed in ASTM C 430.

SECTION 1021

TRAFFIC SIGNALS

1021-1 SIGNAL HEADS:

(a) **General:** Signal and beacon sections shall be adjustable type. Materials and construction of each section shall be the same.

Signal sections shall have 3 to 5 sections per face and beacon sections have 1 section per face. Signal sections and associated brackets shall be finished inside and out with 2 coats of yellow enamel with each coat independently baked. Visors shall be yellow on outside and black on inside.

Edges shall be smooth with no sharp edges.

(b) **Housing, Housing Doors and Visors:** Housing and doors shall be cast aluminum conforming to ASTM B 85 or B 108 with a minimum tensile strength of 17,000 psi. Hardware shall be stainless steel.

(1) **Housing:** Housing shall be sectional and each face shall consist of as many sections as there are optical units, with a top and bottom. Sections shall be fastened together in a manner that provides mechanical integrity and a weatherproof optical unit.

Each face shall be provided with round openings (slip-fit for 2" opening) in top and bottom so it may be rotated 360° and be capable of being directed and locked at 5° intervals. Serrations, detents, bolts or similar locking devices are required. Friction will not be an acceptable lock. Locks shall be such that any face will resist a torque of 20 ft-lb when assembled in accordance with manufacturer's recommendations.

Portion of housing adjacent to bracket shall be reinforced to have sufficient strength against breakage from shock. Seals, gaskets, labyrinths or a suitable combination shall be provided at bracket attachment points and section joints to ensure water shedding. Supporting brackets or trunnions shall be used at top and bottom of section assemblies to support faces.

A 6-position terminal block for connection of wires from socket and incoming wires from signal circuits shall be provided in center section of signal housing and shall include provisions for grounding.

(2) **Housing Doors:** Housing doors shall contain locking devices which can be operated without tools. Door hinge pins shall be designed so that door will not become disconnected from housing when open. Doors shall be field removable.

Weather resisting, mildew-proof neoprene or silicone rubber sponge gasketing between housing and doors shall be provided.

(3) **Visors:** Each signal section shall have a visor which tilts downward approximately 8° from the horizontal. Visors shall be aluminum alloy at least 0.05" thick.

Tunnel visors shall be used where louvers are specified. Louvers shall be 5-vane and painted flat black. Visors shall not permit light filtration between door and visor.

Visors for pedestrian signals shall encompass tops and sides of signal face and be a shape and size to shield face from external light.

(c) **Optical Unit:** Optical unit shall consist of lens, reflector, lamp socket and lamp. Optical unit and visor shall be designed to prevent sunlight from entering unit from above. Optical unit shall be designed and assembled so no light can escape from one indication to another.

(1) **Lens:** Minimum values of luminous transmission and limits of chromaticity for traffic signal lenses shall be as defined in ANSI D 10.1. Lens shall consist of a round 1-piece convex glass which, when mounted, shall have a visible diameter of at least 11-3/4" for 12" signal section and at least 7-3/4" for 8" signal section. Glass shall be free from bubbles, 3/16" to 5/16" thick, and smooth on outside surface. Lens shall be marked to indicate top or bottom. No lettering shall be visible on lens from normal viewing position. Performance of lenses shall be such that when installed in standard traffic signals (equipped with approved lamp and reflector properly operated and focused), appearance, candlepower distribution and intensity, when compensated for absorption due to color, will at least equal light distribution specified in ANSI D 10.1.

Arrow lenses shall be 12" diameter and shall be given 1 coat of black opaque enamel on inside of lens of a thickness sufficient to hide light of a 200-watt lamp behind it. Enamel shall be free from pin holes and applied so that when lens is in use an arrow will be illuminated. Enamel shall be baked or fired into glass and shall not peel or flake during service or when washed. Arrow shall not be visible except when lamp is illuminated.

An alternative method to produce an arrow indication is by use of a noncorrosive metal template affixed in door housing in same manner as lens. Template shall conform and be retained next to concave surface of lens (inside face) to create clear outline of arrow.

(2) **Reflectors:** Reflectors shall be rigidly mounted in housing and arranged to be easily swung out of housing and away from door to provide access to interior of housing. A neoprene or rubber gasket shall be placed between reflector and lens. Gasket shall not be detrimental to optical performance of signal.

Reflectors shall be made of specular Alzak aluminum spun or punched from metal not less than 0.025" thick, with a bead or flange on outer edge to stiffen reflector and ensure trueness of shape. Thickness of anodic coating shall be at least 0.0003". Reflecting surface shall be free of flaws, scratches, defacements or mechanical distortion.

- (3) **Lamps:** Lamps shall conform to the following physical dimensions and design.

<u>Type</u>	<u>Watts</u>	<u>Rated Voltage</u>	<u>Lumen Output</u>	<u>Rated Life,h</u>	<u>Light Center,in.</u>	<u>Bulb Envelope</u>	<u>Operating Position</u>
A	60	125	610	8,000	2 7/16	Clear A-19	Horizontal
B	135	125	1750	6,000	3	Clear A-21	Horizontal

Lamp base shall be brass with a built-in fuse to protect against filament arcing. Lamp filament shall be Type C11V or C9.

Lamp shall have a minimum of 80% krypton gas concentration (volume per volume) for increased lumen output at stated wattage. Lamp shall have the following information etched into glass bulb: manufacturer's name, wattage, voltage rating and average user operating hours. Lamp shall be permanently marked with date of manufacture. Lamp output shall meet candlepower requirement when used in a traffic signal head at rated initial lumens as specified by ITE standards. Lamp shall not consume more than 3% above stated wattage when operated at rated voltage and producing above light output.

Lamp characteristics shall be tested by and recorded in a report from an approved independent testing laboratory.

- (4) **Lamp Receptacle:** Lamp receptacles shall be made of heat resisting materials designed to properly position on a traffic signal lamp with means for correct filament positioning.

Lamp receptacles shall be designed to properly position lamp in lens section. Receptacle shall be provided with a lamp grip to prevent lamp from loosening due to vibration. Provisions shall be made to permit rotation of lamp so that lead wires are up and securely fastened, but shall not permit any change of socket position with respect to optical center of reflector. Metal portion of lamp receptacle shall be brass or copper. A dust-tight gasket (not cork) shall be placed between reflector and lamp socket.

Lamp receptacle shall be provided with 2 color coded No. 18 or larger lead wires, Type TEW, 600-volt, AWM fixture wire with 3/64", 105°C rated thermoplastic insulation, fastened to socket with sufficient length to reach terminal block with reflector fully open. Thermoplastic insulation shall, at 34°F, be capable of being wrapped 6 times around a 1" mandrel without damage to its insulating properties at rated voltage. Each lead shall have a terminal attached to its end for connection to terminal block in signal housing with a screw driver.

- (5) **Pedestrian Signals:** Pedestrian indications shall attract attention of and be readable to pedestrian, day and night, at distances from 10 feet to the full width of area to be crossed.

Indicators shall be rectangular and consist of messages "WALK" and "DON'T WALK".

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When illuminated, "WALK" indication shall be lunar white and "DON'T WALK" indication shall be portland orange meeting ITE standards. All except letters shall be obscured by an opaque material.

When not illuminated, "WALK" and "DON'T WALK" messages shall not be distinguishable by pedestrians at far end of crosswalk. Letters shall be at least 3" high where distance from near curb to pedestrian signal is 60 feet or less, and 4 1/2" high for distances over 60 feet.

Light source shall be designed so that in case of electrical or mechanical failure of the word "DON'T", the word "WALK" of the "DON'T WALK" message will also remain dark.

(d) **Brackets:** Brackets for assembly of 2, 3 and 4-way signal sections shall be constructed to have center of attachment points arranged on a 7 1/2" radius. Attachment to signal head shall be made with 1 1/2" conduit or 3-bolt type fittings with a bolt length 1 1/2". Fittings at center of bracket shall have a removable lower plate for access to wireway.

Bracket at supported end of signal section shall be 1 1/2" conduit and a fitting with cover for access to wireway. Bracket at opposite end of section may be either same as top or solid. A set screw engaging a drilled hole shall be provided at each joint on bracket where conduit type joints are used or an equivalent locking device shall be provided.

Attachment point for mounting on bracket shall be a 2" opening. When slip-fit is used, section shall come with necessary nuts and washers for 1 1/2" conduit. Provisions shall be made for a positive lock to prevent accidental bracket rotation. Locking may be accomplished by means of serrations, detents, set screws or similar devices. Friction locking will not be acceptable. An alternative to 1 1/2" conduit may be a tri-stud type fitting with appropriate washer. Tri-stud length shall be 1 1/2". Unused openings of signal sections shall be closed with a standard waterproof plug for a 1 1/2" opening. Minimum length of plug shall be 1 1/2". Exposed portions of plugs shall be painted to match color of signal heads.

Steel components shall be galvanized in accordance with ASTM A 153.

(e) **Signal Mounts:**

(1) **Support Cable Mount:** Support cable mounted signals shall have a disconnect hanger and clamp described in Subsection 1021-1(g).

(2) **Pedestal Mount:** Pedestal mounts shall have slip fitting for placement on a 4" inside diameter pipe pedestal having set screws for alignment. Bracket assembly shall have provisions for signal cable entrance.

Bracket assembly shall have a weatherproof terminal compartment or box with a removable cover allowing complete access. Box shall have a terminal strip with terminals equal to number of signal indications in signal heads plus 1 or more for common and for equipment ground.

Terminal compartment shall be neat in appearance and shall be adjacent to or near pedestal mount. Feed wires shall not be required to pass through a signal section or face to reach terminal compartment. A terminal compartment integral with bracket will be permitted.

(3) **Mast Arm Mount:** This mount shall have an adjustable stainless steel strap or cable clamp, malleable clamp casting, tightening mechanism, vertical support tube, top and bottom signal head support with set screws, and bolts. Vertical support tube shall be at least 5 feet long.

Supporting brackets, trunnions and fittings shall be cast aluminum, steel or cast iron.

(4) **Side Mount:** Bracket mounting hub shall accept 1 1/2" conduit and provide for a wire opening equivalent to a 1 1/2" conduit. For timber pole installation, side mounts shall have a vertical entrance for 1" conduit.

(5) **Flashing Beacon Signal Mount:** Signal shall attach to support cable by a bracket. Bracket shall have a cable entrance adapter with provisions for balancing and securing signal.

(f) **Backplates:** Back plates shall be designed to fit combination of sections of signal face. Backplates shall be aluminum alloy at least 0.05" thick, shall withstand distortion in 70 mph, and shall be firmly attached to signal face to withstand above wind load and to permit opening of any signal door independent of other doors. Backplates shall extend a minimum of 5 1/2" from signal head in all directions.

Backplates shall be furnished with oven baked black enamel.

(g) **Signal Head Disconnect Hanger:** Hanger shall provide means for connecting and disconnecting signal head electrically and mechanically from signal support cable and span wire without tools.

Hanger, with top and bottom attachments and clamps, shall not increase signal height from span wire to bottom of signal by more than 6".

(1) **Clamp:** Clamp shall be capable of attaching to a 1/4" to 7/16" support cable and shall attach to or be integral with a balance adjusting device and a suitable weatherproof entrance for signal cable. Support cable clamp shall utilize a minimum of "J" or "U" type bolts 3/8" or larger. A 5/8" clevis type suspension clamp shall be provided. Balance adjuster shall be suitable for mating with a clevis-type clamp having a horizontal clearance of 5/8" and pin of 5/8". Steel shall be galvanized in accordance with ASTM A 153.

(2) **Housing:** Housing and accessories shall be aluminum alloy and shall be equipped with a door of similar material. Door shall be held shut by a device operable with one hand without tools and shall not be easily removable. Door, when open, shall provide complete access to interior of housing and a device shall be included to hold door open while working inside hanger.

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Housing shall be equipped with 2 or more weatherproofed openings for signal cable entrance. Openings shall be equipped with suitable bushings for cable protection. Cable entrances shall be capable of accommodating 3 signal cables 1 1/16" diameter. No cable opening shall be less than 1" diameter.

Housing shall be provided with a permanently mounted clamping device to prevent cable from twisting. Clamping device shall not damage cable jacket, insulation or wires.

Housing shall be provided with a 3 1/2" x 3 1/2" cast aluminum flange adaptor for connecting to signal head or bracket.

(3) **Terminal Block and Plug:** An easily accessible pressure type terminal block shall be located in housing and shall accommodate 18 lines. Each terminal shall be permanently numbered for identification, shall accommodate a minimum of 2 conductors AWG No. 12, and shall be sufficiently rugged to permit proper electrical connection without damaging wire.

Terminal block shall be wired to a multi-circuit female jack connector mounted in housing.

A minimum size No. 18 AWG wire, with 600-volt polyethylene or polyvinylchloride insulation, shall be used between terminal strip and jack connector. Numbered terminals on terminal strip shall be wired to corresponding numbered pin in jack connector.

A male plug with clamp for corresponding female jack connector shall be furnished and shall be equipped with 4 feet of cabled leads for connection to signal heads. Wire shall be No. 18 AWG, 600-volt polyethylene or polyvinylchloride insulated and neatly cabled.

1021-2 LOOP DETECTORS AND EQUIPMENT: Loop detection shall be used for vehicle detection on actuated phases of signal operation. Pedestrian push-buttons shall be used as pedestrian detectors.

(a) **Loop Detectors:** Detector units shall conform to NEMA TS1, Section 15, with or without delay and extension timing, as specified.

Two types of inductive detector units are specified, those with and without ability to delay and extend a call, NEMA Type 1 and 1 T.

Detector units shall be suitable for accurate detection of vehicles from motorcycles to tractor-trailer combinations which ordinarily travel public streets and highways with sufficient conductive material, located to permit recognition and response by detector system.

Detector units shall comply with NEMA TS1, Section 15.2.6.

(1) **Amplifier Case:** Amplifier case shall be metal with a protective coating. A removable cover shall be provided to allow access to internal circuitry. Cover shall be removable with hand tools.

(2) Connectors, Switches and Fuses:

- a. Switches, connectors and fuses shall be located on front of unit.
- b. A single connector shall be provided on front of unit to conform to NEMA TS1, Section 15.2.28.1. This connector shall mate with cable connections MS 3106A-18-1S.
- c. Fuseholders shall be permanently labeled identifying size of fuse.
- d. Plug wiring shall be as follows.

<u>Pin¹</u>	<u>Function</u>
A	AC(-)
B	Relay Common
C	AC(+)
D & E	Loop leads
F	Relay (N.O.)
G	Relay (N.C.)
H	Chassis Ground
I	Spare
J	Delay Override

¹ No pins shall be used for any other purpose than those listed above.

(3) Electrical Characteristics

- a. Detector unit outputs shall be relay type as referenced in NEMA TS1, Section 15.2.29.1. Output operation shall be indicated by a high intensity light emitting diode.
- b. Color coding for wire shall be as follows:

<u>FUNCTION</u>	<u>COLOR CODE</u>
Detector Wiring	Not Specified
AC(+)	Black
AC(-)	White
Relay Common	White/Black Stripe
Ground	Green

- c. Operation of detector unit shall conform to NEMA TS1, Section 15.2.1. Detector unit shall retune to a new inductance value following large inductance change.
- d. When sensor loop and loop lead-in network falls outside NEMA TS1, Section 15.2.13 specifications, detector shall generate a fail safe continuous output in both presence and pulse modes. Continuous output shall remain until memory is cleared by removing power or resetting.

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e. When specified, detector unit shall have ability to delay and extend a call to controller. Delay/extension operations shall conform to NEMA TS1, Section 15.2.24.

f. Each switch shall be permanently labeled to identify its function. Each position shall be permanently labeled to identify its mode of operation. Each mode of operation shall be simple to program with 1 switch position assigned to 1 function.

1. Delay time shall begin when a vehicle enters detection area until call relay is closed representing an activation and shall be selectable between 0 and 30 seconds.

2. Extension time shall begin timing when vehicle leaves detection area, continuing activation for selected time. Time shall be selectable from 0 to 7 1/2 seconds.

(4) Detector unit shall have at least 3 selectable frequencies which shall be visible on front of detector unit.

(5) Sensitivity Control shall conform to NEMA TS1, Sections 15.2.14 and 15.2.15. There shall be at least 3 selectable sensitivity ranges located on front of detector unit. Sensitivities shall be nominally 0.02%, 0.08% and 0.32% change in total loop inductance.

(6) Modes of operation shall conform to NEMA TS1, Section 15.21.17. There shall be 2 presence modes and pulse mode. Selected mode shall be indicated on front of detector unit.

a. Long presence mode shall continue to detect same vehicle within detection area for at least 3 1/2 minutes for a Class 1 vehicle.

b. Medium presence mode shall continue to detect same vehicle within detection area for at least 20 seconds for a Class 1 vehicle.

(7) **Fail Safe:** Detector shall operate with sensor loop shorted to ground or of poor quality. Unit shall generate a continuous call when returning failed sensor loop, failed detector unit, or power failure.

(b) **Pedestrian Pushbuttons:** Pedestrian pushbuttons shall consist of a push button and single momentary contact switch in a cast metal housing on which shall be attached pushbutton sign. Cast metal housing shall include fittings for 1/2" conduit on back and bottom. Operating voltage for pedestrian pushbuttons shall not exceed 24 volts DC.

Assembly shall be weatherproof and constructed so that it will be impossible to receive electrical shock under any weather condition.

When a pedestrian pushbutton is attached to a pole, housing shall be shaped to fit curvature of pole.

When a pushbutton is to be mounted on top of a 2 1/2" post, housing shall be provided with a slip-fitter fitting and screws for securing to post.

1021-3 SIGNAL HARDWARE AND EQUIPMENT:

(a) **Tests:** When design tests are specified, documentation may be provided indicating that such tests have previously been satisfactorily completed.

(b) **Miscellaneous Hardware:** Screws, nuts and lock washers shall be stainless steel or galvanized in accordance with ASTM A 153. No self tapping screws shall be used unless approved.

(c) **Pedestal Anchor Bolts:** Steel anchor bolts shall be fitted with 1 hex nut and 1 washer. Nuts, washers and anchor bolts shall be galvanized in accordance with ASTM A 153.

(d) **Support Cable:** Support cable for interconnect and detector support cable shall be 1/4" diameter, and signal support cable and guy wire shall be 3/8" diameter. Cable shall conform to ASTM A 475, 7-strand Siemens-Martin grade with Class A coating.

(e) **Guy Components:** Guying components and hardware shall be galvanized in accordance with ASTM A 123 or A 153.

Guy clamps shall be steel, 3-bolt type, 6" in length, and of proper strand size to fit both sizes of cable. Clamp bolts shall have an upset shoulder fitting into clamp plate.

(f) **Signal Cable:** Cable shall be 600-volt insulated cable. Filler material shall be non-metallic, moisture resistant, non-hygroscopic, non-wicking and non-absorbent. Conductors that are to be marked with tracer in addition to solid color shall have tracer as part of insulation; ink marking is not acceptable. Outside jacket shall not display patterns of conductor lay.

Signal cable shall be No. 14 AWG solid conductor. Interconnect cable shall be No. 16 AWG in the 24-conductor, and No. 12 AWG in the 7-conductor. Material, color code and testing shall conform to IMSA 20-1. Interconnecting cable between intersections for closed loop and telemetry operation shall be 6-pair IMSA 20-2.

Loop lead-in cable shall be tinned No. 14 AWG stranded conductor, twisted pair with overall shield. Cable shall conform to IMSA 50-2. Loop detector wire shall conform to IMSA 51-3 and shall be No. 16 AWG-19 strands/No. 29 AWG copper. Insulation shall be 0.080" XLPE.

(g) **Electrical Junction Box:** Junction boxes shall be constructed of Class 4000A concrete, cast iron or epoxy/sand composite.

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Concrete shall conform to Section 1005. Reinforcement shall consist of welded wire fabric, 4" x 4" No. 4/4 conforming to Subsection 1006-1(e). Pull boxes may be cast-in-place or precast concrete.

Epoxy/sand composite material shall have a minimum compressive strength of 11,000 psi. Manufactured box shall have a minimum compressive strength of 5,000 pounds over any 100 square inch area on cover when installed on box.

1021-4 POLES:

(a) **Pedestal Support Signal Poles:** Base of pedestal shall be cast iron or aluminum and shall be at least 16" wide at the bottom, at least 16" high and shall be octagonal.

Upper end of base shall be threaded to receive a 4" diameter pipe shaft.

Base shall be designed so that it may be fastened to foundation using anchor bolts located 9° apart on circumference of a 12 3/4" diameter circle.

Base shall contain a removable door to allow access to anchor bolts and to permit cable splicing. Door shall be fastened to base using a hex head stainless steel screw into a threaded hole in base.

Shaft shall be 4 1/4" inside diameter welded steel tubing with a minimum 1/8" wall thickness. Lower end of shaft shall be welded to a 6" nipple to screw into base. Shaft shall be a single piece of tubing.

Pedestals shall be finished with at least 1 coat of rustproofing primer and 1 coat of enamel.

Length of pedestal, shaft plus base, shall be a minimum of 8 feet.

(b) **Steel Signal Support Pole:**

(1) **General:** Poles and fittings shall be galvanized in accordance with ASTM A 123 or A 153. Poles shall be suitable for a horizontal load of 4,000 pounds applied 1 foot below top of pole.

(2) **Pole Shaft:** Pole shaft shall have a base diameter of 11" to 11.75". Pole shaft shall be tapered to approximately 7" diameter at top. Pole shaft may have a round or octagonal cross section. A cap shall be used to cover pole shaft top.

Pole shall be designed so that its maximum deflection is as follows:

<u>Pole Length,</u> <u>ft</u>	<u>Maximum Deflection,</u> <u>in./100 lb</u>
26	0.25
28	0.30
30	0.38

(3) **Handholes and Bosses:** A handhole shall be provided approximately 18" above base with approximate dimensions of 4" x 6 1/2" and cover shall be provided. Cover shall be restrained to pole with a 15" stainless steel chain fastened to cover and to inside of handhole so that chain will be inside pole after cover is installed on pole. There shall be no sharp edges on cover, in handhole, or in pole. Cover shall have manufacturer's name and pole height stenciled on it, readable from outside of pole. Stencil shall be legible after galvanizing. Handhole strain bar shall be formed to provide a mechanical lock against handhole to prevent turning. No obstructions shall be in handhole with cover removed. A grounding nut (1/2"-13NC) shall be welded to inside of shaft 90° left horizontal from handhole. A grounding lug shall be provided with each pole.

Poles shall have a 1" and 3" boss centered on a horizontal line 24" from base. When facing bosses, 1" boss shall be maximum of 35° to right of 3" boss. The 3" boss shall be located 180° from handhole. Bosses at top of pole shall be in line with bosses at bottom. Poles shall be shipped with bosses plugged using galvanized steel conduit plugs installed to full thread depth. On octagonal poles, 3" boss shall be centered on one face that is parallel to one edge of base plate.

(c) **Steel Standards and Mast Arms:**

(1) **General:** Standards, mast arms and fittings shall be galvanized in accordance with ASTM A 123 or A 153. Pole height shaft dimensions and wall thickness shall meet specified design requirements and mounting height of signals.

Standards shall consist of straight or uniformly tapered shafts, cylindrical or octagonal in cross section, having a base welded to lower end with anchor bolts. Castings shall be clean and smooth with details well defined and true to pattern. Mechanical control shall prevent arm from twisting on shaft; friction is not acceptable.

Mast arms shall be compatible with poles in materials, strength, shape and size. Mast arms shall slip fit on shaft.

(2) **Handholes and Bosses:** A handhole shall be provided for access to wireway at union of arm and pole shaft. Bosses shall be 1 1/2 FPT in mast arm and set at 45° from horizontal (downward rotation at center of boss, 0° toward arm top). Bosses shall be located a horizontal distance of 10 feet apart, the first located 16" from top of arm. Number of bosses required is listed in the following table.

<u>Arm Length, ft.</u>	<u>Number of Bosses</u>	<u>Shaft Diameter, Inches, Max.</u>	<u>Shaft Base Plate Bolt Circle, Inches, Max.</u>
10-20	2	10	14 1/2
25-30	3	12	15
35-50	4	13	16

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(3) **Hanger Plate:** A hanger plate and horizontal boss shall be at tip of arm. Arm shall have an up-sweep design. Design load on arm shall be sufficient to place a signal head at each boss.

(4) **Design Requirements:** For establishing loads applied to each structure, the following weights and projected areas shall be used for signal heads:

<u>Type</u> ¹	Design Weight Per Signal, <u>lb</u>	<u>Projected Area Per Signal</u> Less Backplates, Backplates, <u>sq ft</u> <u>sq ft</u>	
1-Way, 3 Section	62	4.8	8.9
1-Way, 4 Section	76	6.6	11.2
2-Way, 3 3 Sections	126		
3-Way, 3+3+3	179	8.7	12.2
4-Way, 3+3+3+3 Sections	235	13.35	15.6
		13.2	15.6

¹ When signal heads of a type different from that shown above are used, weights and projected area shown above shall be increased for equipment proposed for use. Adjusted values shall be based on use of 12" diameter lenses and backplates (when used) extending 5" beyond signal enclosure.

(5) **Standard Shaft:** Standard shaft base shall have a minimum diameter of 11". Mast arm standards shall be provided with a transformer type base.

Pole shall be bolted to transformer base with 4 hex head bolts with 2 washers and 1 nut for each bolt.

(6) **Transformer Base:** Transformer base shall be approximately 20" high. Top of transformer base shall have 4 slots 1 1/2" x 2 1/2" for bolting pole to transformer base. The 2 1/2" dimension of slot shall be centered on and perpendicular to a 13 1/2" bolt circle.

A removal panel on side of transformer base shall be provided for access to base. A 1/2" 13NC grounding nut shall be provided 90° left of panel. A grounding lug shall be provided with each pole. Bottom of transformer base shall fit a 16" bolt circle using four 1-3/4" bolts supplied with each pole. These bolts shall conform to these specifications except that cap nuts shall be replaced with hex nuts. Transformer base shall be capable of being rotated 360°.

(7) **Wireways:** Pole shaft and mast arm shall be suitable for wireways throughout their length.

(d) **Treated Timber Poles:** Poles shall conform to Section 1013.

SECTION 1022

LANDSCAPE AND EROSION CONTROL MATERIALS

1022-1 TOPSOIL: Topsoil shall be fertile, friable, natural surface soil obtained from a well drained area and free of rocks, hard lumps, roots, weeds, trash and other debris. Topsoil shall have a minimum PI of 4, and an acidity range of pH 5.0 to 8.5.

1022-2 FERTILIZER: Fertilizer shall be a commercial type conforming to commercial fertilizer laws as regulated by Louisiana Department of Agriculture and Forestry. Chemical composition shall be as specified and shall be designated by a 3-number sequence representing minimum percentages by weight, respectively, of nitrogen (N), available phosphoric acid (P_2O_5), and soluble potash (K_2O). Fertilizer in granulated or pelletized form shall be packaged in moisture proof containers.

1022-3 GRASS SEED: Seed shall conform to requirements of Louisiana Law.

(a) **Seed Mixtures:** Standard seed mixture shall be 1 part Hulled Bermuda and 2 parts Carpet Grass. An alternate mixture shall be 1 part Hulled Bermuda and 1 part Pensacola Bahia. Other types of seed, such as rye grass, may be used with approval.

(b) **Seed Analysis:** Each variety of seed shall be furnished and delivered in separate containers. Each container shall bear an analysis tag. Analysis tag shall be a No. 6 standard shipping tag and shall carry information required by Louisiana Seed Law.

Seed shall be of previous season's crop, and date of analysis shown on each tag shall be within 6 months of time of delivery to project.

Pure live seed and weed seed content shall be as follows:

Variety of Seed	Minimum % of Pure	Maximum % Of Weed
	<u>Live Seed</u>	<u>Seed</u>
Hulled Bermuda	86	1
Carpet Grass	76	2
Pensacola Bahia	81	2

Undesirable weeds shall mean that list of weeds, except Bermuda, which has been adopted by Louisiana Seed Commission as being noxious in Louisiana. Undesirable weed seeds shall not exceed 500 per pound.

1022-4 PLANTS:

(a) **State and Federal Regulations:** Plants shall be free from injurious insect pests and plant diseases and subject to regulations of Federal and State Departments of Agriculture. Shipments of plants shall comply with nursery inspection and plant quarantine regulations of the states of origin and destination. The contractor shall obtain proper certificates for movement of nursery stock. A copy of the Certificate of Inspection shall accompany each delivery.

(b) **Plant Names:** Scientific and common plant names shall conform to the current edition of "Hortus." Plants shall be true to name and legibly tagged.

(c) **Grading Standards:** Grading of plants shall conform to the "American Standards for Nursery Stock," published by American Association of Nurserymen, Inc.

(d) **Quality and Source of Plants:** Plants shall be nursery grown, well formed, and at least No. 1 Grade.

Plants and trees shall be measured before pruning, with branches in normal position. Dimensions for height and spread refer to main body of plant and not from branch tip to branch tip. Determining measurements for trees shall be caliper or height. Caliper of trunk shall be taken 6" above ground for sizes up to and including 4", and 12" above ground level for larger sizes. Trees shall have growth which is normal for the species. Plants shall be healthy and free from insects, diseases and injuries.

The contractor shall not trim or cut leaders or main branches of trees.

(e) **Balled and Burlapped Plants:** Balled and burlapped plants shall be dug with firm, natural balls of soil of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of plant. Balls shall be wrapped with burlap or similar material and bound with twine, cord or wire. Plants shall be watered prior to transportation.

(f) **Container Grown Plants:** Container grown stock which has become potbound or in which the top system is out of proportion (larger) to the size of the container will not be acceptable. The stock shall have a fibrous, cohesive root system. Plants shall be watered prior to transportation.

(g) **Delivery of Plants:** The contractor shall notify the engineer at least 24 hours before delivery of plants to project. Each shipment shall be accompanied by an invoice showing sizes and varieties.

(h) **Deficiencies:** Plants shall be free of the following deficiencies: excessive abrasions of bark, dried out root system, excessive dead wood, dried up wood, excessive sun scald injuries, undeveloped and weak top or roots, crooked or onesided development of tops, no straight leaders on trees normally having them, broken or removed leaders, untrue types or sizes, not complying with laws or regulations bearing on inspection and certificates, excessively damaged balls of soil, balls of soil dug from soil which will not properly ball, or dead plants.

1022-5 STRAW AND FIBER MULCH:

(a) **Straw:** Mulch shall be pine straw, stems of oats, rye, rice, wheat or other approved straws. The contractor may also use hay from lespedezas, clover, vetches, soybeans, Bermuda, Dallis, carpet sedge, fescue or other approved legumes or grasses. Straw or hay shall be dry and free from mold or noxious weeds.

(b) **Fiber:** Mulch shall be produced from ground newsprint with not more than 7% ash content or from grinding clean wood chips.

1022-6 ASPHALT MULCH: Asphalt for mulch shall be emulsified asphalt Grade SS-1 or SS-1h conforming to Section 1003.

1022-7 EROSION CONTROL MATTING:

1022-7.1 Straw Matting: Straw matting shall be a machine produced mat of straw covered with a biodegradable yarn on maximum 3" centers with a maximum stitch length of 3". Straw shall be stems of oats, rye, rice, wheat or other approved straws. Matting shall have a minimum weight of 0.5 pound per square yard and shall be furnished with protection for outdoor storage.

1022-7.2 Excelsior Matting: Excelsior matting shall be a machine produced mat of curled wood excelsior covered with a biodegradable extruded plastic mesh or other approved biodegradable material and shall be made smolder-resistant without chemical additives. Wood fibers shall be of consistent thickness, with 80% of fibers being at least 6" long, and shall be evenly distributed in matting. Matting shall have a minimum weight of 0.8 pound per square yard and shall be furnished with protection for outdoor storage.

1022-7.3 Staples: Staples shall be 8 gage wire, U-shaped, with a 1" crown; or T-shaped with the bar of T at least 4" long with the single wire end bent downward approximately 3/4". Staple legs shall be at least 8" long.

1022-7.4 Wood Stakes: Stakes shall be 1" x 2" x 12" wedge-shaped wood stakes.

1022-8 GEOTEXTILE FABRIC: Geotextile fabric shall be a product listed in the QPL and shall be composed of at least 85% by weight of polyolefins, polyesters or polyamides. Fabric shall be resistant to chemical attack, rot and mildew and shall have no tears or defects which adversely alter its physical properties. When required, fabric shall contain stabilizers or inhibitors to make filaments resistant to deterioration due to ultraviolet and heat exposure. Edges of fabric shall be finished to prevent outer yarn from pulling away from fabric.

Fibers of other composition may be woven into fabric for reinforcing. Durability of these fibers shall be equivalent to that of the geotextile fabric.

Geotextile fabric rolls shall have an opaque, waterproof wrapping. Each roll shall be labeled with manufacturer's name, date of manufacture, batch number and name of product.

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Geotextile fabric shall be utilized as follows:

<u>Use</u>	<u>Classes</u>
(1) Drainage:	
Underdrains	A, B, C or D
Pipe and Precast Box Culvert Joints	A, B, C or D
Weep Holes	A, B, C or D
Bedding Fabric	B, C or D
Approach Slabs	D
(2) Stabilization:	
Bulkheads	C or D
Flexible Revetments	C or D
Rip Rap	D
Railroad Crossings	D
Soil Stabilization	C, D or S
(2) Silt Fencing:	
Wire Supported	F
Self Supported	G

1022-9 SLAB SOD: Slab sod shall be Bermuda, carpet or St. Augustine grass sod cut within 2 days of placement to a soil depth of 1" - 1 1/2".

SECTION 1023

RAILROAD GRADE CROSSING MATERIALS

1023-1 BALLAST: Ballast shall be crushed stone conforming to the following requirements:

	Test <u>Method</u>	<u>Requirement</u>
Soft & Friable Pieces, %, max.	AASHTO T 189	5.0
Material Passing No. 200 Sieve, %, max.	AASHTO T 11	1.0
Clay Lumps, %, max.	AASHTO T 112	0.5
Soundness, 5 cyc., Magnesium Sulfate Sol., % loss, max.	AASHTO T 104	15.0
Abrasion Loss, %, max.	AASHTO T 96	40.0
Dry Rodded Weight, lbs./cu. ft., min.	AASHTO T 19	70.0

The material shall be graded as follows when tested by AASHTO T 27.

<u>U.S. Sieve</u>	<u>% Passing</u>
3"	100
2"	90-100
1"	20-55
3/8"	0-15

1023-2 TIES:

(a) **General:** Ties shall be Size 3 (minimum) treated timber conforming to Railway Tie Association (RTA) specifications as modified by the following requirements:

(1) **Species of Wood:** Ties shall be of ash, beech, gum, hackberry, hickory, oak or sycamore.

(2) **Treatment:** Ties shall be air dried in accordance with AWPAC6. Ties shall be adzed and bored in accordance with AREA Specifications (Chapter 3, Section 1.5) before treatment. Ties shall be treated with creosote coal-tar solution conforming to AWPAC2, Grade A or B. The treatment process shall conform to AWPAC6. The minimum net retention of preservative shall be 10.0 lbs./cu.ft. or refusal.

(3) **Ties Exhibiting Splits:** Ties that exhibit splitting shall not be used unless an approved S-shaped metal anti-splitting device is driven into each end of such ties.

(4) **Certification:** A supplier's certification shall be furnished to the engineer stating that the preservative treatment of the ties conforms to these specifications.

1023-3 TIE PLATES, JOINT BARS, BOLT ASSEMBLIES, SPIKES AND RAIL ANCHORS:

(a) **General:** Each shipment of these materials will be accepted on the basis of certificates of analysis from the manufacturer or supplier showing chemical and physical properties in accordance with the applicable specifications.

(b) **Tie Plates:** Tie plates shall conform to ASTM Designation: A 67, Grade 1 or 2.

(c) **Joint Bars:** Joint bars shall conform to ASTM Designation: A 49, except that high carbon steel bars shall meet the following chemical and tensile properties:

	<u>Requirement</u>
Chemical Properties:	
Carbon, %, min.	0.45
Phosphorous, %, max.	0.04
Tensile Properties:	
Tensile Strength, psi, min.	85,000
Elongation in 2 in., %, min.	15

(d) **Bolt Assemblies:** Bolt assemblies shall conform to ASTM Designation: A 183, Grade 2.

(e) **Spikes:** Track spikes shall conform to ASTM Designation: A 65.

(f) **Rail Anchors:** Rail anchors shall be high carbon spring steel conforming to the following requirements.

(1) **Chemical Composition:**

	Percent	
	<u>Min.</u>	<u>Max.</u>
Carbon	0.65	0.88
Manganese	0.60	1.10
Phosphorous	----	0.04
Sulfur	----	0.05

(2) **Physical Properties:**

	<u>Requirement</u>
Tensile strength, psi, min.	160,000
Yield point, psi min.	120,000
Elongation in 2", %, min.	7
Hardness	362 - 415 BHN

1023-4 PERFORATED PIPE: This shall be perforated bituminous coated corrugated steel pipe conforming to Subsection 1015-3.

1023-5 GEOTEXTILE FABRIC: Fabric shall conform to Subsection 1022-8.

(a) **Treated Timber:** Crossing sections, header boards and shims, shall be made of a fine-grained hardwood timber of red oak or gum. The gum shall be one of the following, stated in order of preference: (1) black gum, (2) tupelo gum or (3) sweet gum.

Timber shall be treated with creosote or creosote coal-tar preservative in accordance with AREA specifications.

(b) **Elastomeric:** Elastomeric assembly units shall be an approved product on the QPL. The elastomeric assembly shall consist of elastomeric units, creosote treated timber shims (as may apply), end plates, washers and plugs, steel washers, metal spikes and galvanized lag screws.

Crossing pads shall be of steel reinforced molded elastomer with an acceptable non-skid pattern on the riding surface.

(c) **Precast Concrete:** Precast concrete assembly units shall be listed in the QPL. The precast concrete assembly shall consist of full depth precast panels constructed of Class 6.5A5000 concrete conforming to Section 1005. Reinforcing shall be Grade 60 deformed bars. Surface of units shall have a skid-resistant finish. Edges of panels shall be protected by the use of angle iron conforming to ASTM A 709, Grade 36. Panels shall be equipped with properly spaced holes for anchoring and lifting lugs. Lag screw holes and lifting lugs shall be recessed for a smooth ride. Steel washers used in anchoring panels shall be galvanized in accordance with ASTM A 153. A 1/8" neoprene bearing pad with a Shore "A" Durometer hardness of 60±10 shall be used as a cushion under panels to resist abrasion of ties.

Panels shall be marked with the date cast.

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